AGRICULTURAL ENGINEERING

NOVEMBER 1943

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THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

New Ways Make
Grass Greater Than Grain

Grass now grows more feed per acre, produces more meat and milk, brings forth more wealth than the same land will yield with grain. Henceforth grass shall no more be a poor relation in the farming system, but the ace of all crops. Grassland farming means rotations not built around wheat or corn, but around grass . . . grass not merely for rough, thin land, but the richest and most level fields.

Grass grown on fertile soils rich in available nitrogen, if grazed or cut when a few inches high, actually contains as much protein as green legumes. This is doubly important in times when protein concentrates may be scarce and high-priced. In a few weeks it is ready to graze or mow again.

On slopes too steep for cultivation, grass is more than feed; it is the salvation of soil. Contour furrows made with plow or lister halt runaway water, stop it from stealing soil, save it to soak into subsoil and sustain grass growth during dry spells. And when the rains return, that same carpet of green shelters the soil from surface erosion by pelting drops.

Renovation of permanent pastures adds to their feeding capacity, often doubles it. Starved, root-bound sod is opened up with regular field tiller or spring-tooth harrow, preferably equipped with alfalfa teeth. In some conditions disk harrows can be used. Reseeding, in the small amounts desired, is done accurately with grass-seed attachment of a grain drill. Fertilizer attachment for the same drill, or use of a fertilizer drill, fortifies the soil for stronger growth of old and new grass.

Grass is destined to play a major part in the new agriculture now unfolding. It promises new security for soils and for families. It points the way to better human health through more nourishing meat and milk. Give thought to the promise of grass as you look forward to the methods and machines which will serve you best when machinery again is freely available.

The experiment stations in your own and near-by states have developed and proved methods for grass growing and pasture improvement. By bulletins and through the extension services they will gladly help you to choose the methods best suited to your farm. Likewise your Case dealer stands ready to help you apply these methods with the machines you already have or may hire from neighbors. Use his service also to keep your machinery working like new and prolong its life. J. I. Case Co., Racine, Wis.

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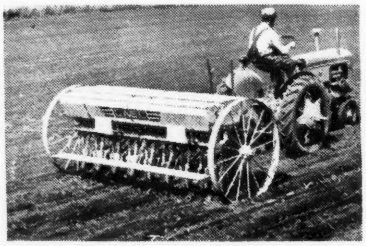

With the eager, easily-handled power of a Case tractor, it is easy to put plenty of grass in your rotation. With tandem hitch of roller-packer and Case Seedmeter drill, fitted with grass seed and fertilizer attachments, you can crush clods, firm the seedbed, fertilize and sow accurately both the small amount of grass or legume seed and its nurse crop of grain.

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SERVING AGRICULTURE *Since 1842* IN PEACE AND WAR

As a service to agriculture, this message is appearing in farm papers. It is one of a series urging farmers to adopt advanced practices, using equipment they already have to promote war-time food production and conserve agricultural resources. J. I. Case Co., Racine, Wis.

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AGRICULTURAL ENGINEERING

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Vol. 24, No. 11

EDITORIAL

The Rabbit Is Right

COMMENTING on the editorial entitled "Food Should Cost More," on this page last month, an A.S.A.E. member says, in part:

"In the consideration of the costs of food, entirely too much attention is paid to the farmer and the worker, while the man who must live on a salary which varies within rather narrow limits is really the goat.

"Possibly I should say rabbit rather than goat, as the white-collar man makes very little noise and has many of the other characteristics of the rabbit in the present situation. If you are going to go after inflation, go after inflation where it is to be found and don't throw those of us who have no 'surplus income' to the wolves, represented by the pressure groups in Washington . . . It would seem to me that AGRICULTURAL ENGINEERING would represent very largely a group which is in the (white-collar) class mentioned above."

He is quite right that our profession consists mainly of men whose incomes are relatively inflexible. What with increased taxes, enforced bond buying and contributions under pressure, most of their available incomes have been very substantially reduced, not increased. Among them are all who have any part, direct or indirect, in the unsigned utterances which appear from month to month on this page. The editorial "we" shares with him the full force of the unfairness which he cites.

However, it has been our habit to consider here not the personal interests of our profession and ourselves, but rather our professional interests and the broad welfare of the agriculture and the America which we serve. In our personal interests and injustices we are but a tiny fraction in the great group of forgotten white-collar men. Possibly we lean backward in leaving their human problems to remembrance, all too rare, by more general and more eloquent commentators, among whom may be mentioned Gabriel Heatter.

Costs Are the Key

PRACTICALLY all of our financial problems, present and future, revolve around the pivotal fact that we are making the war cost too much. We shall make little progress toward bringing order out of our economic chaos until we have the honesty, intellectual and otherwise, to face the obvious fact that costs consist of wages or other forms of human compensation. Material costs are only wages put into mining, lumbering, transportation, etc. Taxes, now a major item in costs, are mainly salaries to persons on public payrolls and wages paid by government suppliers.

At best, war is costly. It is too costly both because we are using human labor inefficiently and because we pay too much for it. In an economy of destruction, which is what war is, every effort to provide all the people with sufficient pay to maintain an unimpaired, or only slightly impaired, standard of living is an attempt to fight a war without paying for it. Every such effort is a factor in a formula for inflation.

Efforts to spare favored fractions of the population from the costs and deprivations of war are doubly vicious because they are shameless attempts to shift the burden of war to the shoulders of the remaining part of the people. Equality of sacrifice should be more than an empty shibboleth. It must be a substantial reality not merely for reasons of justice and morale, but to prevent slowing or stopping of our whole economic machine by burning out some of its vital bearings.

Impartial stabilization, or actual reduction, of human compensation will ease our ultimate burden and that of our children manyfold. The exact amount of such easing will depend on the ratio between the borrowed or deferred part of war's cost and that currently borne. Such stabilization is the function of management, if it is free, or of government if it is not. To either, the engineer can contribute straight thinking and moral support.

Directly, engineers can cut down the excessive costs of war by making more efficient use of human labor. Every application of power, of machine, or of chemical process which gets a job done with an hour less of human labor cuts down by just that much the bill we pass on to posterity, or in some small measure pay ourselves. Only efficiency, in terms of human time and toil, can cheat the costs charged up for war, and efficiency is the essence of engineering.

Besides their obvious duty as technicians, engineers have another obligation in the efficiency which war demands. Better than anyone else they know and can compute the losses due to such abuses as feather-bedding, production limits, etc. They will fall short of their full patriotic duty if they fail to point out all such waste of human and material capacity.

Subsidy Is Futile

PROBABLY there are exceptional circumstances in which subsidies are justifiable, but we cannot see in the present circumstances any justification for a general subsidy on food. Certainly it is not needed for agriculture at a time when farm income is far higher than it ever was before, and even inefficient operators are making good money. An A.S.A.E. member who operates a rather larger-than-average farm recently remarked that he was ashamed of those self-appointed spokesmen who represent farmers as needing or wanting higher unit prices for their products.

He points out that higher prices will not create any more man power for agriculture, and at best would only divert it from other essential employment. More money will not make available any more farm power and machinery, and farmers already have enough money to bid more for old machines than they cost when new.

As we have repeatedly remarked, consumers generally neither need nor deserve a subsidy to reduce the cost of food when non-agricultural income is at an all-time high and the percentage of that income required for food is at an all-time low. Indeed, food wastage and extravagance are a part of the food problem. Points, not pennies, limit the diets of most families, and a subsidy will not put more pictures into ration books.

The exception to all this is the fixed-income family referred to as rabbits in a quotation elsewhere on this page. They, and they alone, need any subsidy. They need it no more on food to keep them from starving than on fuel and clothing to keep them from freezing. It would be far better to subsidize this unfortunate minority directly as such than to aggravate the inflation problem by feeding the entire population in part with money borrowed from the public treasury and charged to our children.

Resistance of Shelled Corn and Bin Walls to Air Flow

By S. Milton Henderson
MEMBER A.S.A.E.

IN THE design of a natural or a mechanical ventilating system for drying high-moisture shelled corn, reliable data on the resistance of the passage of air is highly desirable. Data for wheat and rice have been published[1,2*], but little information is available for shelled corn, especially for low air pressures encountered in natural ventilation. The purpose of the studies described in this paper was to make such information available. Other factors, including settling, presence of cracked corn and foreign material, and the amount of openings in bin and ventilator walls upon air flow, were also evaluated.

Experimental Apparatus. The apparatus (Fig. 1) was similar to that used by Kelly[1] and Stirniman[2] in studies with other grains. except for supplying air. An air pressure tank (A) was connected to a plenum chamber (B) by a short length of pipe fitted with a globe valve (C).

The stack or column for holding grain (G), 8½ in in diameter and 8 ft high, was made in 2-ft sections. The quantity of air available from the pressure tank and the advisability of moderately long runs to assure accuracy in individual tests largely governed the size of stack selected. A piece of hardware cloth inserted between the stack and plenum chamber supported the column of corn. Perforated steel sheets of types used in storage bins were substituted for the hardware cloth and tested, both with and without corn, for resistance to passage of air.

A piezometer ring (J) was placed around the plenum chamber to make accurate static pressure observations. Similar rings were also placed at various heights of the stack in order to determine the pressure gradient through the corn. These pressures were observed with a water manometer (I) which is shown in detail in Fig. 2. The air temperatures in the plenum chamber and the pressure tank were observed by thermocouples.

Test Procedure. The tank was filled with compressed air to a pressure of approximately 80 in of mercury (40 lb per sq in) prior to the beginning of a test. Compression of the air in the tank caused the temperature to rise well above 100 F (degrees Fahrenheit). The test run was started after air in the tank had cooled 10 to 15 deg above room temperature. The valve C was opened and adjusted to the desired plenum pressure observed on the inclined water manometer (D) Figs. 1 and 2—which could be read to 0.01 in. After adjustment to the desired plenum pressure, the time, pressure, and temperature of the air in tank A were noted simultaneously and respectively by a stop watch, a mercury manometer (E), and a thermocouple located within the tank, the leads of which can be seen at F, Fig. 1. The plenum pressure was held constant by adjusting the valve during the run, thus assuring a constant rate of air flow through the corn. At the end of the run the valve was closed quickly and the time again noted. After the temperature of the air in the tank had reached or nearly reached room temperature, the final tank pressure and temperature were read. The amount of air displaced during the run was calculated from the well-known gas equations correlating temperature, pressure, and volume.

The corn tested had a moisture content of approximately 9.6 per cent; total damage, 1.4 per cent; and test weight, 55½ lb. It was hand-screened over a standard 12/64-in corn sieve to remove all cracked corn and foreign material.

The stack was filled in 1-ft increments, care being exercised to prevent unnecessary packing. Runs at various pressures were made for each foot of depth.

Calculation of Air Flow. The rate of air flow is equal to the amount of air discharged from the tank per unit of time. All calculations were made on the basis of atmospheric air at 30 in of mercury and 70 F.

The rate of flow (Q) through the corn, expressed as cubic feet of air per minute per square foot of floor area, is given by the expression

$$Q = \frac{V T_a}{P_a A t}\left(\frac{P_o}{T_o} - \frac{P_t}{T_t}\right)$$

in which

V = volume of tank in cubic feet
T_a = absolute temperature of air in plenum chamber
P_a = atmospheric air pressure
t = time of run in minutes
A = cross-sectional area of grain stack in square feet
P_o = absolute pressure of air in tank at beginning of run
P_t = absolute pressure of air in tank at end of run
T_o = absolute temperature of air in tank at beginning of run
T_t = absolute temperature of air in tank at end of run.

Experimental Error. No errors other than the accidental errors were observed, except in the observation of temperature of the air in the pressure tank, T_o, at the beginning of the test run and the error introduced by the variations in barometric pressure from the assumed value of 30 in of mercury.

The initial pressure reading, P_o, was made a few seconds after opening the valve on the pressure tank. The expansion of the air in the tank caused a reduction in temperature due to decompression of the air which was not accurately indicated by the thermocouple due to its temperature lag.

The temperature lag of the thermocouple was checked under laboratory conditions and the maximum temperature difference possible was determined by assuming adiabatic expansion of the air in the tank. The error in observation was calculated to be less than 1 F which would effect an error in the calculated rate of air flow of less than 0.5 per cent.

The effect of variations in barometric pressure upon the observed values for any one depth of corn was negligible. However, the fluctuation from day to day, averaging approximately 0.1 in of mercury, was sufficient to cause some variation in the relative position of the curves for the various depths. This amount of variation would cause an error not exceeding 0.5 per cent.

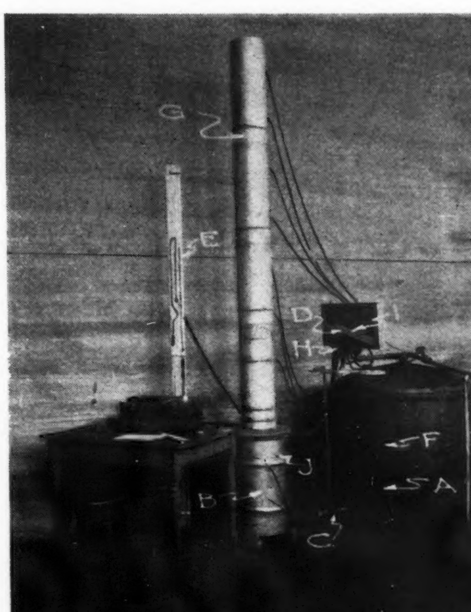

Fig. 1 Apparatus used for studying the rate of air flow through shelled corn

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S. M. HENDERSON is agent, grain storage investigations, farm structures research (BPISAE, ERA), U. S. Department of Agriculture.

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*Superscript numbers indicate the references appended to this paper.

The standard error or deviation of the individual observations from the average line drawn in Fig. 3 is an excellent measure of the accidental error. It is less than 1 cu ft per min per sq ft.

Resistance of Clean Corn. The results of the tests made with corn free of foreign material and without settling, are given in Fig. 3. The relationship between the rate of flow and pressure for a given depth of corn is of the form $Q = KP^c$ in which K is a function of the depth of the grain and c the slope of the curve. Values of K and c were determined for the various depths and are tabulated in Table 1.

TABLE 1. CALCULATED VALUES FOR THE CONSTANTS K AND c (BASED ON FIG. 3)

Grain depth, ft	K	c
1	53.5	0.582
2	38.2	0.574
3	28.2	0.626
4	24.4	0.616
5	21.2	0.636
6	18.3	0.660
7	16.0	0.673
8	14.7	0.669

K was found to be equal to $58.9D^{-0.66}$ and c equal to $0.562D^{0.089}$.

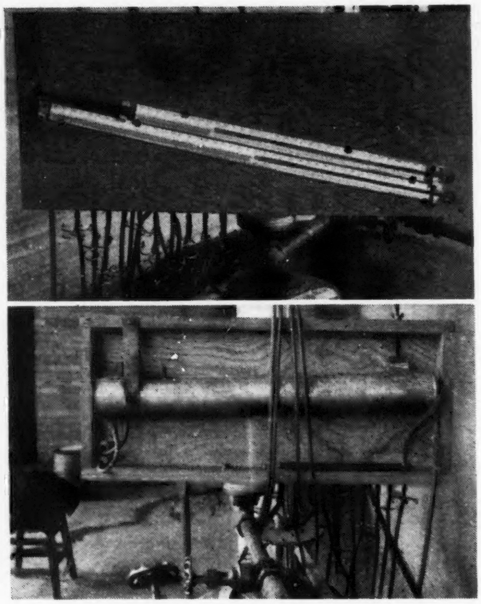


Fig. 2 Front and rear views of the inclined water manometer used for observation pressures in the plenum chamber and the pressure drop through the stack

The complete mathematical expression is given in Fig. 3. The formula may be simplified to

$$Q = \frac{59P^{0.63}}{D^{0.66}}$$

which is accurate to within 2 per cent of the more complete expression. These formulas probably apply reasonably well for pressures and depths both above and below those of the study.

A number of tests were made with corn which had been graded to size and shape. The results of this part of the study are reported in Table 2. The following observations are to be noted. The size and shape of kernels affect the resistance to air flow. Corn weighing only 24.4 g per 100 kernels (No. 1) permitted only 93 per cent as much air to pass as did larger kernels weighing 32.0 g per 100 (No. 9). Rectangular to round kernels weighing 33.0 g per 100 (No. 6) were more resistant to air flow than smaller round kernels weighing only 31.0 g per 100 (No. 3). Also note that the blends (Nos. 7 and 8) are more resistant than the unmixed corn of Nos. 2, 3, and 5 used for blending. It is evident that the variation between varieties will cause considerable variation in the estimated quantities of air flowing. The corn used for determining Fig. 3 was No. 9 in the table and was representative of average corn.

TABLE 2. RELATIVE RATES OF AIR FLOW THROUGH CORN CHARACTERIZED BY VARIOUS TEST WEIGHT, KERNEL SHAPE, SIZE, AND WEIGHT

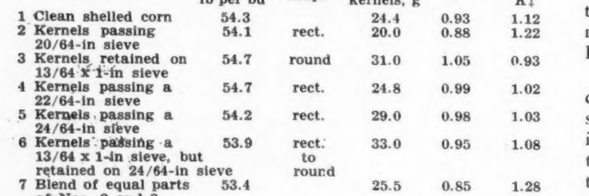
No.	Corn Description	Test weight, lb per bu	Kernel shape	Weight of 100 kernels, g	Rel. Q*	Depth factor K‡
1	Clean shelled corn	54.3		24.4	0.93	1.12
2	Kernels passing 20/64-in sieve	54.1	rect.	20.0	0.88	1.22
3	Kernels retained on 13/64 x 1-in sieve	54.7	round	31.0	1.05	0.93
4	Kernels passing a 22/64-in sieve	54.7	rect.	24.8	0.99	1.02
5	Kernels passing a 24/64-in sieve	54.2	rect.	29.0	0.98	1.03
6	Kernels passing a 13/64 x 1-in sieve, but retained on 24/64-in sieve	53.9	rect. to round	33.0	0.95	1.08
7	Blend of equal parts of Nos. 2 and 3	53.4		25.5	0.85	1.28
8	Blend of equal parts of Nos. 2 and 5	53.9		24.5	0.76	1.52
9	Clean shelled corn, larger kernels than No. 1	55.5		32.0†	1.00	1.00

*Relative $Q = Q$ for test corn divided by Q for clean shelled corn from storage (No. 9) †Estimated

‡This factor times the depth of corn will give the depth of clean shelled corn (Fig. 3) with equivalent resistance

Effect of Settling. After completion of the tests with 8 ft of clean corn (Fig. 3) settling was accomplished by agitation of the stack and tamping of the corn. This caused corn to settle 3-3/16 in in 8 ft. A set of runs made following this settling showed that the rate of flow had been reduced to 85 per cent of that previous to settling. Since more settling of the corn was probably accomplished than that in a bin, the reduction is probably greater than that encountered under typical conditions.

Effect of the Presence of Foreign Material. The void space in corn has been reported as 40 per cent[3]. The increase in resistance



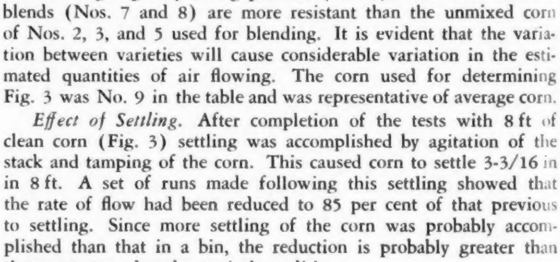


Fig. 3 (Left) Rate of air flow through clean shelled corn of various depths for various pressures. The corn weighed 55½ lb per bu; 100 kernels weighed 32.0 g. The effect of tamping at the 8-ft depth is also shown • Fig. 4 (Right) The effect of cracked corn and foreign material upon the rate of air flow. The relative Q shows the relationship between the rate of flow of air through shelled corn containing foreign material as compared with clean shelled corn. The depth factor F is the ratio of the depth of unclean corn to that of clean corn of equivalent resistance to air flow

due to the presence of foreign material partially filling the voids in the corn was observed.

Foreign material which had previously been screened from shelled corn was added to the clean corn in various amounts and complete sets of runs made as with clean corn. Tests were made with corn in depths of 2, 3, and 5 ft. The degree of fineness of the foreign material was determined by screening a representative sample over standard mesh sieves. This sieve analysis is shown in Table 3, the results of the study in Fig. 4.

TABLE 3. SIEVE ANALYSIS OF FOREIGN MATERIAL

Mesh of sieve	Per cent of material retained
12/16-in grain dockage sieve	18.3*
6	15.4
8	27.5
12	19.1
14	10.9
20	4.5
	4.3

*Cracked and small kernels, small pieces of cob, and husks

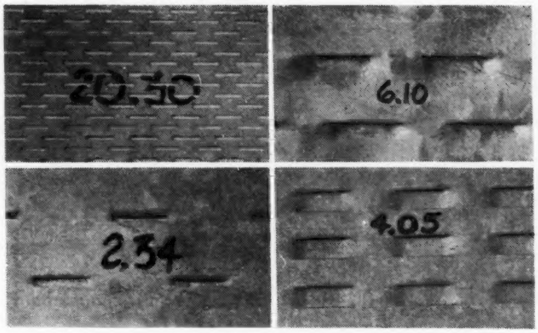


Fig. 5 The four general types of perforated sheets used for resistance tests; the numbers show the per cent of opening. (Type 1, upper left; Type 2, upper right; Type 3, lower left; Type 4, lower right)

The variation in reduction of the rate of flow for the various amounts of foreign material was due to the non-uniform mixture. Although great care was exercised in blending the foreign material and clean corn, samples taken after testing indicated an uneven distribution of the foreign material. However, since foreign material is usually found unevenly distributed in bins, it is probable that the relationship shown in Fig. 4 is representative of average conditions.

Resistance of Perforated Steel Sheets. The perforated steel sheets used for test represented some of the typical types being used for ventilators, walls, and floors in grain bins. The percentage of opening for each of the sample sheets was determined.

The data taken were analyzed in the same manner as the shelled corn resistance data. The relationships were found to be represented by the following formula:

$$Q = 3000\ pP^{0.52}$$

in which Q = rate of air flow, cubic feet per square foot per minute
p = per cent of opening in sheet
P = air pressure, inches of water

Resistance of Perforated Steel Sheets with Corn. The resistance of the perforated steel sheets with corn was determined by observing the pressure drop across the steel sheets and that across the column of corn (Fig. 6). The ratio of these pressure drops gives the relative resistance of the sheet with that of the corn. For example, the pressure drop across sheet B in Fig. 6 is 1.6 in water and that across 3 ft of shelled corn is 1.9 in. The resistance of the sheet is, then, the product of the ratio 1.6/1.9 and 3, or 2.53 ft of clean shelled corn.

The results of the tests with corn over steel sheets are given in Table 4, and in Fig. 7. The four different types of sheets tested are shown in Fig. 5.

The added resistance with corn was evidently due to the reduction of the effective openings by the kernels. The reduction was the greatest in the sheets with large rectangular-shaped perforations. For instance, the corn caused the resistance of sheet in test No. 4 to increase 9.3 times. However, with the sheet reversed so the perforations would project into the corn (test No. 5), the resistance was increased only 4.1 times. A large number of small perforations is to be preferred over a smaller number of larger perforations for the same amount of opening.

An approximate relationship between the resistance of perforated sheets and clean corn is shown in Fig. 7. The hyperbolic curves were fitted to observed data by the method of least squares.

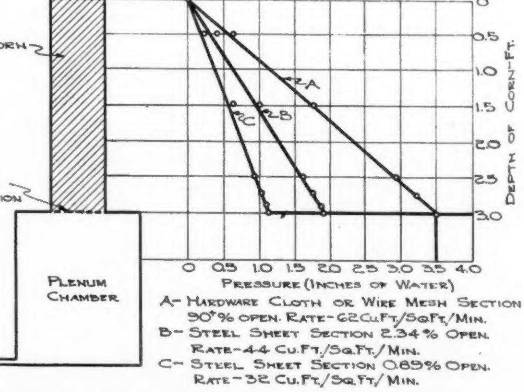
TABLE 4. RESISTANCE TO AIR FLOW OF PERFORATED STEEL SHEETS WITH CORN

(Three feet of corn was used in all the tests. Comparable results were secured for two tests made with 6 ft of corn)

Test No.	Type of perforation (Fig. 5)	Amount of sheet open, %	Approx. width of perforation, in	Narrowest perforation width, in	Ratio of observed pressure drops across sheet*	Resistance of perforation sheet (depth of clean corn in ft)
1	1	51.00	0.18	0.18	1	0
2	1	20.30	0.06	0.06	1	0
3	2	6.10	0.25	0.13	3.5	0.5
4	3	4.77	0.40	0.11	9.3	1.0
5	3	4.77	0.11	0.11	4.1	0.6
6	4	4.05	0.25	0.04	2.4	0.4
7	2	3.30	0.25	0.11	5.5	1.2
8	2	2.75	0.25	0.12	6.6	2.8
9	3	2.34	0.15	0.07	4.1	2.6
10	3	1.83	0.15	0.07	3.6	3.2
11	2	0.89	0.30	0.09	2.4	6.6
12	3	0.85	0.10	0.05	1.9	6.7

*Ratio of the observed pressure drop across the sheet with corn to that without corn

Use of Data. The data given in Fig. 3 can be used to determine either the rate of flow through shelled corn for a given pressure or the static pressure required to produce a given rate of flow. With aid of the data given in Figs. 4 and 7 *(Continued on page 374)*



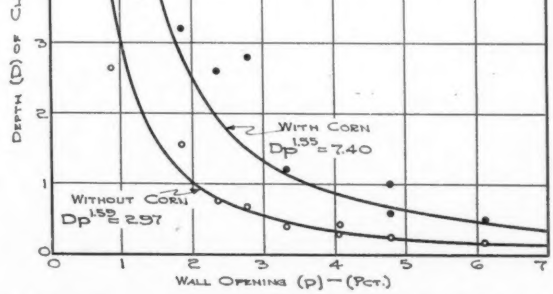


Fig. 6 (Left) Pressure gradients through 3 ft of corn and across perforated sheets with different amounts of opening at a plenum pressure of 3.5 in water • Fig. 7 (Right) Resistance to air flow of perforated steel sheets with different openings with and without shelled corn. The resistance is expressed in equivalent depths of clean corn

The Fighting Agricultural Engineers

By Arthur W. Turner
PRESIDENT, AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

I AM sure you are interested in knowing what our A.S.A.E. membership is doing today and how it is serving on the various fronts — also in having brought to your attention some of our opportunities and responsibilities.

Our Society service flag has 230 blue stars. These members are serving on every front, many of them in executive and specialized work because of their previous training and experience.

Another group, not as large as the one comprising members in armed forces, is serving wartime agencies in official Washington. They are working quietly and efficiently, characteristic of the engineer, without fanfare and each one doing his job. Our Society objective is to render technical service to agriculture, and that is what you will find these agricultural engineers doing. There are several in the farm machinery branch of WPB. Some are in other branches of WPB, and in WFA and OPA; still others are serving as consultants and supervisors where their engineering knowledge of agriculture is invaluable. And closely allied with them are the agricultural engineers in other government service who, like those in the war agencies, are in there fighting for the farmer so he can come closer to meeting the increased demands for farm production.

There are also the agricultural engineers in federal and state experiment stations and on college staffs who are directing their attention and energies to solving problems on the food front.

A large percentage of our membership is in industry where they are engaged temporarily in producing war goods, including design, materials, plant layout, production procedure, training plant personnel, and training the armed forces in the use of new weapons. Paralleling these activities our members are helping with new developments to provide equipment and procedures so American farms can produce many essential agricultural products formerly imported, such as edible fats and oils, paint and drying oils, soap fats, glycerine, rubber, hemp and other cordage fibers, tapioca and other root and tropical starches, sugar, tanning materials, and insecticides. All this involves problems of proper soil and moisture conditions, soil preparation, crop cultivation, harvest, storage, transportation, and often partial processing which must be solved by the men who are fighting to maintain America and her allies.

The war has placed new responsibilities on our doorstep. One of these is the problem of producing food in areas occupied by our armed forces and in other areas outside our country. Many, if not all, countries can increase their food production. In fact, they will have to for the United States and Canada cannot meet the world food requirements. Even if we could produce the food here, we would be unable, under wartime conditions, to transport it to the hungry nations. So the alternative is to produce as much of it as possible near where it is to be consumed.

MECHANIZED EQUIPMENT WILL BE EFFECTIVE IF THE NATIVES ARE TRAINED ON HOW TO USE AND MAINTAIN IT

What is needed to make that possible? Will mechanized equipment and streamlined farming increase production over night? It might, if the land was prepared and laid out to accommodate the equipment. It might, if enough capable people went along to train the natives how to use and maintain the equipment. It might, if additional water, through irrigation, was provided. These *ifs* are based on the premise that the same crops could be grown on lands in other countries that we produce in volume here.

And that takes into account only the growing of the crops. How about livestock, poultry, dairy products — and facilities for producing them? Crops, fruits, vegetables, animals, and animal products will need to be processed, stored, preserved, and transported to where they will be consumed.

And with reference to the matter of providing water for irrigation, in tropical and semitropical lands malaria and other insect-carried diseases become epidemics if proper sanitation procedures are not practiced. It is obvious that this is an engineering task.

All these things call for agricultural engineering in all four of its branches — soil and water conservation and management, rural electrification, grain storages and animal shelters, and power and machinery. While cooperative assistance from the entomologist, agronomist, and animal husbandman is necessary, it is in the main an engineer's job.

A special committee of our Society with experience in other countries is studying this problem of how agricultural engineers may help supply the need abroad for the kind of service they are capable of rendering as a group.

However, we should perhaps not be too much concerned about the aftereffects of the war on American agriculture. Wheeler McMillen, editor-in-chief of Farm Journal and Farmer's Wife, and a member of our Society, said in an address at our last annual meeting: "The world is growing hungry in this year of global blood-shed and destruction. For most of the areas of the world, this will not be the first time that the threat of famine has alarmed cities and countryside. Starvation has been recurrent through all the generations of man.

" . . . Perhaps it is true to say that in America are the only people who have never in their history experienced a famine. Our record is a little less than perfect, for not all Americans have been shown how to earn their share of our plenty.

"The foremost interest of every family in the world is food, closely followed by the other essentials of living, such as clothing and shelter. No family in chronic want of these basic necessities can be much interested in other matters. The hungry man with a hungry family is not likely to turn his mind to problems of world federation . . . . "

And then in conclusion Mr. McMillen said, "Poverty, the lack of food and goods, may not be the only cause of wars. I will venture, however, as a reasonable hypothesis well worth the most vigorous efforts to explode, that a substantial increase in production in all lands will guarantee peace more firmly and for longer than any other course that will be proposed."

THE WAR HAS BROUGHT OUT EMPHATICALLY THE FACT THAT MUCH MORE FOOD IS NEEDED FOR ALL THE WORLD

Those statements emphasize the need in the world for more food for all time. This war has brought that fact emphatically to the attention of all. It is more than producing and transporting food to reduce hunger and prevent famines, it is essential to lasting peace. More food — food produced in larger quantities at reduced cost — has been the agricultural engineers' objective for years. Social legislation of the past decade has hindered the utilization of our efforts. Fortunately we went ahead and were devising new methods of speeding farm production. All of those plans and devices are now in use and more are demanded. Surely as agricultural engineers we have been building for the peace to come.

Perhaps we should look forward to some of our agricultural engineers on the fighting fronts bringing back information about crops and animals that will be studied and their commercial applications exploited. Herein lie possible challenges for us. Also, agricultural engineers are among the research engineers who are studying the application to agriculture of radar, electronics, temperatures, plastics, synthetics, textiles, insulation, light metals, motor fuels, improved internal-combustion engines, and many others. The future of the agricultural engineer is most promising. In fact, you should be impatient to tell the story to youth now in high schools and to his parents. Our colleges should develop shortcut training for the men now in the armed forces for service in these new fields so that agricultural engineering as a profession may fulfill its obligation of technical service to agriculture.

We are all interested in ways and means to meet the challenge of agriculture. Why? So that there may be a better day for agriculture. Perhaps the words of one of our past-presidents, Geo. W. Kable, best states my thought — " To broaden the smile on the face of agriculture." He made that statement before the United States entered the war. The smiles have (Continued on page 374)

An address before a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at New York, September 1943.

ARTHUR W. TURNER is educational adviser, International Harvester Co.

Farm Mechanization in Wartime

By Frank J. Zink
MEMBER A.S.A.E.

THE mechanization of agriculture including the full scope of agricultural engineering progress is fairly well cataloged by the historical accounts of wars. War histories, being written usually from the political viewpoint, do not contain many direct references to the use of engineering applications in agriculture. In fact, there is seldom any direct mention of information of the kind. On the other hand, food and water supplies are commonly referred to in our war histories. Yet when we stop to reflect upon the factors of food production, land, labor, and the production facilities, the last of which includes all phases of agricultural engineering — structures, equipment, irrigation, drainage, erosion control, power, fuel, and the various supplies for the use of these facilities — we at once begin to realize their importance in any war period. In general, it is to be understood that land and labor alone will produce food, even though insignificant supplies of seeds and tools are available. Many a victory gardener learned this during the past season. However, we generally recognize also that the amount of time in which to wage a war is available in quantity inversely in relation to the degree the third factor is used for food production.

History does not indicate just how many wars were not conducted because the people were too busy producing their food supplies, yet it may be concluded that there were a great many.

Most wars are instrumental in initiating matters denoting progress. In wartime, often many years of agricultural tradition are abandoned solely because of war pressure. Decades of normal progress in this country have been telescoped into two or three years. Even today China with its 2,000 years of the use of intensive hand labor is undergoing industrialization, following which some mechanization of agriculture will undoubtedly take place.

Many of the agricultural and food techniques of the last 150 years adequately trace their incentives for development or application to some war. Further, since the developments initiated for food and fiber production have fathered much of our modern industry, the actual progeny of the equipment is now finding its way directly to the battle fronts.

It is now said that earth-moving equipment, having its inception in the agricultural tractor and the plow, is a very important and often the key factor toward our success in modern battles. For example, tractors and highway equipment are credited with saving the lives of 140,000 men hopelessly penned up in Burma. In the eastern Sicilian campaign the same type of equipment pushed through a military highway by following a mountainside goat path where no highway existed before, resulting in unhinging the German lines with a flanking movement. Then, too, similar tools construct and maintain the airfields in all battle areas. Pictures of current landings show equipment familiar to agricultural engineers.

An address before a meeting of the North Atlantic Section of American Society of Agricultural Engineers at New York, September, 1943.

FRANK J. ZINK is agricultural engineer, Farm Equipment Institute.

A few of the wartime incentives which have resulted in wartime food contributions requiring a decreased mantime may be of interest in brief.

A prize offered by Napoleon resulted directly in the development of the technique for the preservation of food by means of canning. The process was of little value to Napoleon, but it has since meant a great deal to civilization, both in war and peacetime.

Eli Whitney multiplied man power 200 times with the cotton gin, which was undoubtedly inspired, financially at least, by the widow of a general in Washington's army. He later was inspired and did contribute interchangeable parts procedure in the making of firearms. As an agricultural equipment inventor and an engineer, he in part became the father of the scheme of mass production now widely used in industry. Both developments were without doubt presaged by the acute needs for clothing and firearms during the Revolutionary War. Neither modern warfare nor modern agriculture could be possible without the use of mass production methods.

The adaptation of horse-operated agricultural equipment to the prairies of the United States permitted the Union to have ample wheat supplies, both for food and for export, resulting in maintaining trade relationships with England. This was an important factor in the final outcome of the Civil War. On the other hand, the shrinking agricultural economy in both man power and equipment for food production was an important factor in the capitulation of the South. Even down to date both results have been incentives to the peacetime progress of the two regions. The South chose to continue principally on a handwork basis whereas the North strove for greater degrees of agricultural improvement, both biologically and mechanically. The incentives beginning in the Civil War pushed the mechanization of agriculture in the North particularly of the labor-saving type with the result that most of the farm equipment industry centers in the northern prairie states.

During World War I, labor-saving machinery and especially mechanical power was pushed much farther and faster in most regions of the country. Labor-saving equipment was still the urgent reason for further use and application of engineering knowledge. During this period, except for a marked incentive to change from animal to mechanical power, there was begun the tendency to combine agricultural equipment operations. This tendency has continued through the period since World War I. Faster and more timely operations along with a greater use of equipment for quality value considerations of crops handled largely were the outgrowth of incentives established in the first world war.

During the past two years the farm equipment industry and agricultural engineering in general have been coping with war problems. This period has a story to be told, especially for historical purposes, but perhaps it would be better to hold to the engineering angle. Agricultural engineers are, no doubt, more interested in the current problems of food production, and, too, it might be well to

One of the newest machines that promises to contribute much to the future progress of the mechanization of agriculture is the self-propelled combined harvester-thresher, two views of which are shown here

look beyond our current situation and perhaps try to view some bits or pieces of information on facts which may indicate the shape of things to come during the continuation of the war and possibly after the war period.

In passing, some information relating to the farm equipment industry is essential to any consideration of current war and future engineering problems.

The farm equipment industry in the war period is carrying a joint responsibility both for war goods production and for farm equipment production, the latter of which has a direct interest both for war and civilian interest. War production began early in the industry, being well under way before the Pearl Harbor incident. On October 2, 1941, Colonel (now General) Donald Armstrong stated that 37 per cent of the ordnance contracts under his supervision in the Chicago district were with members of the Farm Equipment Institute. The total figure of the value of these contracts together with the value of contracts in force by the farm equipment manufacturers in other districts plus the amount of contracts with other government agencies for war account I would estimate to be well over two-thirds of the business done in a normal year by the industry.

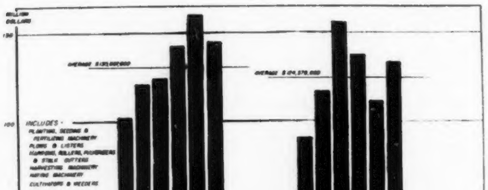


Fig. 1 Domestic sales of farm equipment in the United States, from U. S. Census figures

About a year ago the industry was engaged in the production of military supplies and war equipment with contracts in force amounting to approximately twice the normal annual business in the production of farm equipment. Currently there has been no tendency to slacken the rate of production of war goods.

Since the industry is engaged also in the production of regulated amounts of farm equipment as well as production of war goods, it can readily be seen that the industry is endeavoring to carry out its responsibilities to the best of its ability.

While war production has been continuing, the industry has been engaging in a program of farm equipment manufacture on a scale set forth by various production quotas. These quotas and their dates of application allowing for maximum production of farm equipment for the industry as a whole are as follows:

1 The first order, dated July 23, 1941, covered the period August, September, and October, 1941, limiting production to 120 per cent of the same period in the previous year. This order operated under the priorities system and was known as P-95.

2 The second order, dated December 31, 1941, covered the period from November 1, 1941, to October 31, 1942, limiting farm equipment production to an average 83 per cent of 1940. This order was known as limitation order L-26.

3 The third order, dated October 19, 1942, covered the period from November 1, 1942, to October 31, 1943, limiting farm equipment manufacture to 20 per cent of 1940-41. This order was known as L-170. (This order was accompanied by a so-called concentration feature whereby the smaller manufacturers produced a greater percentage of their base years goods than did the larger manufacturers. Even the production of the smaller manufacturers was, however, a dilution of their production for the period as compared with their base year.)

4 The fourth order, dated June 15, 1943, covers the period July 1, 1943, to July 1, 1944, limiting production of farm equipment to an average 80 per cent of the larger year of either 1940 or 1941. This order is L-257. (This order has since been amended so that it is continuous for the duration of the war.)

This current order with its amendment enables manufacturers to plan ahead on their production schedules with some forseeable volume. It is anticipated in conjunction with this program that some percentage changes applying to individual items of equipment may be made as warranted by food demands. It is further anticipated that these changes may be made in advance of equipment production schedules to permit of orderly manufacturing operations. This last order, together with its continuing amendment, has relieved a great deal of the uncertainty which the manufacturer had previously in conjunction with the three earlier orders.

The farm equipment industry through their many thousands of dealers are fully aware of the fact that these various limitation orders have not allowed anywhere near the volume of goods that are currently demanded or have been demanded by agriculture. The industry also recognizes that some plants in the industry have a great deal more capacity for production than is permitted under the current order. On the other hand, in other plants the present increase of war tempo may result in a limitation of production through the shortage of man power rather than through the shortage of materials as has been the case during the past year at least. Recent reports indicate that man power is rapidly becoming an imminent factor in the limitation on production. Apparently, it is difficult to effect an equilibrium between man power and materials. Inasmuch as man power does not have a similarly effective priority as does the supply of materials, the general picture apparently is about to change. Just what will be the final outcome at the end of the year of production of equipment only time may reveal.

Press releases based upon the advent of the order L-257 have in general been more optimistic than present conditions now in the industry seem to warrant. In this connection it should be pointed out that a quota percentage under any limitation order is quite a different thing from a completed equipment production schedule. It is impossible to harvest soybeans with a combine which cannot be produced through failure of supply of man power or materials, although that combine was allowed for in the initial order.

It is my thought that agricultural engineers are interested in some of the agricultural engineering aspects of the current war period, as these influence the production of food. While these are immediate problems confronting the farm equipment industry which accrue from the war situation, they do have engineering aspects.

First, I believe it is important that we as engineers recognize the full impact of past and present limitation orders on the equipment supply with which to extend and maintain our food production facilities.

In the early limitation orders production quotas were based on numbers of units rather than on overall tonnages of materials of a critical nature which could be used. This double limitation tended to remove any incentive of the engineer to make the materials available produce just as many machines as possible. Most engineers know where they could have made materials go farther under a condition of a limited supply without detracting from the service rendered by machines. Apparently those in the ivory citadel felt that they had the best answer to this particular question and therefore preferred not to trust the initiative of the farm equipment engineers.

It has long been recognized by equipment engineers that in some areas of the country heavier machines are required than in other areas. In fact, the farm equipment industry as a whole has been criticized frequently for making machines too rugged and for putting into those machines too many years of service life, the thought being apparently that a machine which is made to last too long may interfere with the desired flexibility for changes in management by the farmer. This too long a service life may, and then again may not, be a liability. It all depends on the individual merits of specific cases. On the whole, however, this longevity of farm equipment life has been a wartime asset accruing to agriculture, and too it has been a direct contribution of the agricultural engineer. This longer equipment life has aided farmers materially in carrying them through their situation of short equipment supplies during the past several months. However, it must be recognized that from the food production point of view, we must be especially conscious of results of carrying such a program too far.

The replacement rate of farm equipment has been a strongly controverted matter during the preparation of a number of the earlier orders. Unfortunately, agricultural engineers had little actual data on which to make accurate determinations. Since this question was raised within the last two years, some bits of information are

now coming to light. An example of this is a survey made by members of the staff at the University of Missouri. Professor O. R. Johnson recently reported that a 2 per cent replacement rate of farm machines had been found in Missouri.

As agricultural engineers, we must recognize that there are two types of equipment depreciation on our farms. The first type is due to ordinary wear and tear, which accrues from ordinary use of farm equipment. This type of depreciation proceeds slowly under normal conditions, yet in wartime it does speed up for two reasons: (1) Greater use of at least the higher capacity machines, the result of the tendency to overcome man power shortages, and (2) less competent help and therefore less competent operation. The second form of depreciation is a result of obsolescence which because of some physical change in the farm setup takes place rapidly and is largely confined to a wartime situation. In such a condition, a reasonably new farm machine perhaps needs to be replaced by an even newer machine. This is done necessarily to offset crop, labor, or machine organization and management changes. Such changes may take place during a single season or within a week. Examples of these are loss of labor from the farm, which labor cannot be replaced, and changes of cropping practices on a particular farm or within a farm area. New crops or new war crops are also examples. What may be regarded as an obsolete machine for one farm may be a modern tool for another farm where its physical life may permit of a great many more years of service. This type of interchange of equipment has long operated in agriculture, and is a specially active procedure in change-over from animal power to mechanical power.

This point indicates that production quotas together with relatively inflexible distribution methods are not possessed of a flexibility such that a farm operator can readily apply to his changing needs.

Another point which I believe deserves to be understood is that while the development work which takes place within the farm equipment industry during any single-year period may not be of significant value as a wartime measure, certainly several years of such development and improvement work may effect some problems during the continuation of the war. Currently the shortage of both materials and man power needed for an orderly development program make it more difficult under the production quotas. If our country is called upon to supply substantial amounts of food to foreign account and should we have less favorable weather conditions for crop production, serious consequences may result through the arrested improvement program for farm equipment.

My point is that orders limiting production, issued as conservation measures on materials, have tended to curtail normal progressive machinery improvement. This type of program does not offer the flexibility necessary so that the farmer may select machines which in their early stages were just being introduced and had been produced, therefore, in the base years in limited numbers.

It has been noted that high demands exist for machines which save great amounts of farm labor. Other reasons for such demands are that farmers desire higher operating speeds, hence greater capacity; or sometimes just greater capacity by means of larger machines, and for those machines which can be operated by means of either reduced labor forces or marginal labor forces now on a great many farms.

Thus the new machines for next year's farm use are several years behind the times in design. It is to be noted that war equipment has been readily improved, and largely so as battle results have demonstrated the necessity for such improvement. Yet on the other hand, even though "food comes first", our food production equipment is relatively static from the point of view of even normal improvement. Any congealing of equipment design, which in a way is tantamount to standardization, is not now compatible with our war food effort, first, because of the greater food requirement necessary, and, second, because there is less labor capacity with which to produce this food.

I believe that agricultural engineers are conscious of the fact that a dollar invested in basic machines is going farther today than a dollar invested in basic machines did twenty years ago. While I believe no substantial research points to the truth of this statement, I feel that it is in part indicated by a chart (Fig. 1) illustrating the domestic sales of farm equipment, basic machines including plows and listers, harrows, rollers, pulverizers, planting, seeding, and fertilizing machinery, cultivators and weeders, harvesting machinery, and haying machinery for two rather similar periods from 1925 to 1930 as compared with 1935 to 1940 inclusive. During the first period farmers purchased at wholesale value approximately $131,000,000 worth of such basic machines. During the second period they purchased approximately $125,000,000 of such basic machines. Fig. 1 graphically compares these two periods.

It has been said that for lend-lease account together with increased domestic needs for food that we could put to use any amount of food that it is possible to produce during any of the current war years. The agricultural engineer, together with the equipment and production facilities which he has developed, is very effectual in producing certain types of foods. He has been able to markedly increase the calories produced per hour of labor input of a great many items.

At present there is much discussion on the rather controversial subject of whether or not we should have a cereal diet or a meat and milk diet. It is not my intention to enter into this controversy, but I do wish to point out by means of Fig. 2 which graphically illustrates the calories produced per hour of labor, that some types of food and feed crops, being highly mechanized, are produced with relatively small input of labor. On the other hand, some types of foods, especially those in demand which have dietetic value such as meat, dairy products, and vegetables, are very much lower in energy value per unit of labor required. The mechanization of these various food and feed items is strongly illustrated by this chart. In showing this relationship I wish to state that I am not advocating literally that we put on the feed bag instead of living as usual on a good chunk of roast beef or pork, plus some ice cream or some strawberries. I believe, however, it well illustrates the application of agricultural engineering through farm equipment, structures, and other farm related industries.

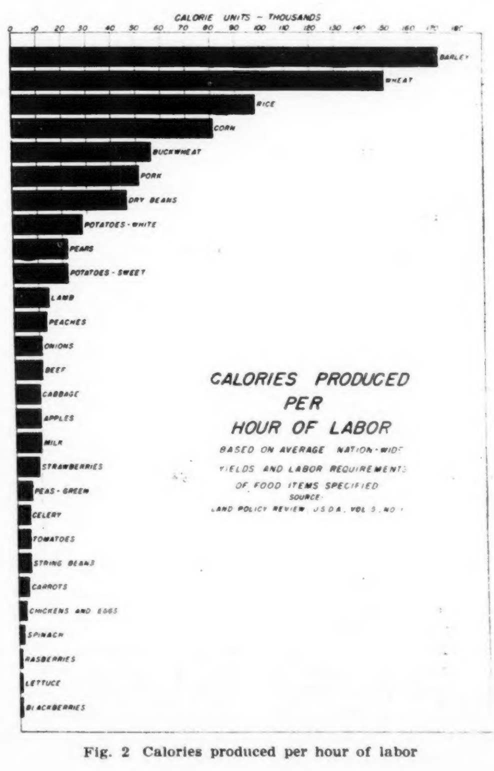


Fig. 2 Calories produced per hour of labor

If we are called upon to change our diet and can live upon a higher ratio of cereals than we have been accustomed to, it is indicated in part what food items, high in energy value, are highly mechanized and can be produced in greater quantities without marked increases of labor input.

In addition to this I want to point out that our agricultural yield of some 600 million acres of land can only be obtained by means of an adequate livestock economy, this approximate amount of land in the United States being unfit for anything but grazing. Also, even though some of these food items are low yielders of energy values

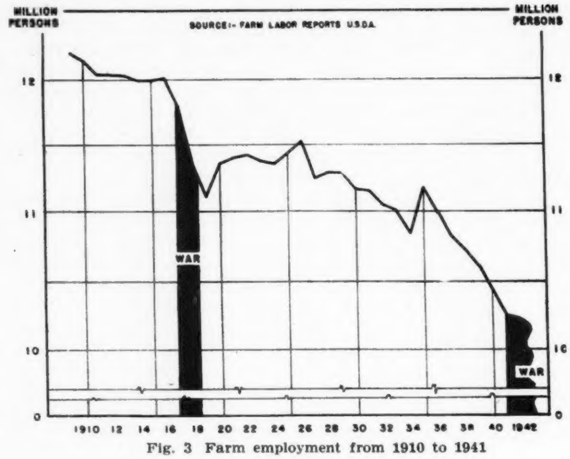


Fig. 3 Farm employment from 1910 to 1941

per hour of labor input, they represent net gains of food through the absorption of unused labor on farms which would be otherwise unproductive or wasted. This is the same type of case as with the victory gardens, the food from which may not be economically produced as a business proposition, but a lot of us sidewalk farmers have no other place where we can gainfully use our extra time. In this regard perhaps nothing is more significant that all of us working on a limited hour schedule could therefore work longer hours in industry and thus relieve the man power shortage, which is a thought expressed before by others.

The farm labor situation is also of interest to us as engineers in the food and farm equipment programs. Graphic information on this subject is offered by Fig. 3.

It is reported by the farm labor reports of the USDA that we still use in agriculture approximately the same number of persons on the annual basis as were working in 1941. According to the June 23, 1943, farm labor report, about 13 per cent of our farm workers were under 14 years of age. Also, according to the same report, 27 per cent were female. From another source, USDA reports, one year earlier, we learn that one-seventh of our farm workers were over 64 years of age. One-seventh is approximately 14 per cent. Thus we have currently approximately 55 per cent of our labor force coming from these marginal groups.

Thus there have been absorbed into agricultural work approximately five million persons. This means that a similar number have left agriculture for the armed services and for war industries. As a wartime problem facing agriculture, the farm equipment industry and agricultural engineers in our over-all efforts to produce food, what is going to be the farm labor situation for the remainder of the war period. Frankly, it is my opinion that we must be especially alert to this potentially critical problem.

Those in the ivory citadel have opined that still more labor can be obtained from these groups.

Many farmers have worked longer hours since the war began to offset the labor shortages. An example of this is reported by Wright in a survey of 249 Michigan farms. He states, "The labor supply per 100 acres declined 10 per cent, while work accomplished per man increased 9 per cent in the two years." The period was from 1940 to 1942. This was accompanied by both increased machinery investment and crop and livestock production during the two years.

Fig. 3 also shows the pattern of agricultural labor changes in World War I. The period after World War II is of interest to agricultural engineers and also to the farm equipment industry. Is the trend after the war going to be anything like the period after World War I? If it is, nearly four million men will not return to agricultural work. If one were to discount this figure by 50 per cent, we will still have two million fewer farm workers. The work of these two million men is not likely to continue to be done by the women, youngsters, or old men; therefore, it is entirely possible that farmers will want a great deal more machinery of the labor-saving type just like they have been trying to get during the last couple of years. Whether there will be one, two, or four million persons to return to agriculture will depend, I believe, upon the opportunity for employment in the cities and in other industry.

The Fighting Agricultural Engineers

(Continued from page 370)

given way largely to work and anxiety. We want those smiles to return. As human beings and especially as engineers, we are here to build, not destroy. As citizens we must take an active part in civil affairs, whether local, state, federal, or world-wide, using our talents and our influence toward a permanent peace. We must ever be diligent and forward looking in our Americanism.

The Bible says: "For what is a man profited, if he shall gain the whole world, and lose his own soul." To paraphrase, what will it profit America if she win the war and then, out of weariness, lose the peace, even our own freedom? We must keep alert and fight this war all the way through. What shall we say to those 230 blue star members when they return, if we have not preserved America and helped lay the foundations of a world order based on reason and understanding? We are and we must continue to be "*fighting* agricultural engineers."

Resistance of Shelled Corn and Bin Walls to Air Flow

(Continued from page 369)

such factors as the presence of cracked corn and foreign material, and the reduction in flow due to the added resistance of openings in the floor, can also be taken into account.

Clean Corn. Considering a depth of 4 ft of shelled corn, the rate of flow for a pressure of 1 in of water is 24 cu ft per min per sq ft of a column of corn, as revealed by Fig. 3, providing the corn is clean and the resistance to air flow of the floor is negligible.

Unclean Corn. If, however, the corn contains, say, 3 per cent cracked corn and foreign material, the reduction in the air flow can be determined from Fig. 4. Fig. 4 shows that the equivalent depth of clean corn is 20 per cent greater, or 1.2 times that of corn with 3 per cent cracked corn and foreign material, which in this case would be 4.8 ft. From Fig. 3, the flow for a pressure of 1 in of water for this depth is 22 cu ft per min, a reduction of 2 cu ft per min.

Floor Openings. To illustrate the effect of openings in a floor on resistance, assume openings of 2 per cent. From Fig. 7 it is noted that this amount of opening in the floor with shelled corn produces a resistance equivalent to 2.5 ft of clean corn. This, plus the 4-ft column of corn, gives a total equivalent depth of 6.5 ft with clean corn and the flow for this depth for 1-in water pressure is shown by Fig. 3 to be 17 cu ft per min per sq ft. Corn with 3 per cent cracked kernels and foreign material as noted above is equivalent to a depth of 4.8 ft of clean corn, which, added to 2.5 ft resulting from the use of a perforated floor, produces a total equivalent depth of 7.3 ft, and the flow for this depth for 1-in water pressure is shown by Fig. 3 to be 15.5 cu ft per min per sq ft.

Account may also be taken of the settling of the corn, but quantitative data on the effect of settling was not obtained. It may be estimated from Fig. 3 that a maximum reduction of about 15 per cent in flow through 8 ft of shelled corn was produced by tamping.

REFERENCES

[1]Kelly, C. F. Methods of ventilating wheat in farm storage. U. S. Dept. of Agri. Cir. 544. 1940.

[2]Stirniman, G. P., et al. Tests on resistance to the passage of air through rough rice in a deep bin. Agri. Engr. 12:145-148. 1931.

[3]Zink, F. G. Specific gravity and air space of grains and seeds. Agri. Engr. 16:439-440. 1935.

Farm Structures a Challenge

THE farm structures engineer must be a jack-of-all-trades. He must qualify as a structural engineer, as a sanitarian, as a farm manager, often as a livestock or crop specialist. Farm structures present an engineering problem and challenge of the first magnitude. How well we accept that challenge now and in the future is strictly up to us. In my opinion the American Society of Agricultural Engineers has before it a golden opportunity to assume leadership in rendering a real service to agriculture through such encouragement as it can give to the improvement of farm structures.

Farm Needs in Electric Equipment

By J. P. Schaenzer
MEMBER A.S.A.E.

IN December 1942 the Rural Electrification Administration conducted a survey of 41 selected electrified farms in Ohio and Indiana, the object of which was to determine the changes that had taken place in the farming operations, production enterprises, and labor before and after electrification. The length of time that electric service was available to them ranged from one to five years, the average being 3 years and 11 months.

The farms visited were selected by the superintendents of the local REA cooperatives. In order to secure information on the part that electricity plays on the farm it was necessary to select farms having a higher than average energy consumption. During 1942, the average energy consumption for these 41 farms was 466 kw-hr per month. Only through studying the farms using electricity abundantly and primarily for farming operations is it possible to determine the benefits to be derived from it in increased production, increased capacity for work per individual, and the effect upon labor. Certainly it would be impossible to get such information from the 50-kw-hr per month consumer. It is also known that the farms surveyed were above the average in size, equipment, and facilities. In many cases the operators were among the leaders in their respective communities. Nevertheless it seems that the approach used was the only one available that would serve as an illustration of the advantages to be gained from farm electrification.

Cognizance should also be taken of the fact that changes were taking place on these farms from the time they were electrified to the time the survey was made. The number of horses used for field work was reduced, the tractors increased, better tillage and harvesting equipment was acquired, and other factors such as educational campaigns, the war, stabilization and increase of prices undoubtedly also had their effects. Yet every farmer interviewed, without exception, stated that electric service was a major factor in increasing his food production and decreasing his labor in the performance of specific farm chores.

A summary of the facts and figures on the production before and after electrification of these 41 farms follows:

	Number		Per cent
	Before	After	Increase
Acres in farms	7,586	9,630	27
Acres (irrigated)	10	15	50
Acres (seed corn)	105	290	176
Milk cows	356	520	46
Beef cattle (market)	403	489	21
Hogs (market)	3,316	4,487	35
Sheep (western ewes)		250	all
Sheep (lambs)	475	475	none
Sheep (feeders)	750		*
Meat processing (T per yr)	218	1,768	710
Laying hens	12,530	19,447	55
Chicks (brooded)	50,025	78,750	57
Chicks (hatched)	350,000	807,000	130
Turkeys	11,000	23,000	109
Apples (bu, est.)	2,000	12,000	500
Vegetables (market)			95

*Discontinued feeding lambs.

Only a few typical statements from farmers as to how electric service has helped in increasing the size of the farming enterprises and its corresponding effect upon labor follow:

An Ohio farmer states that the milking machine has enabled him to increase his dairy herd from 4 to 19 head. No additional help is required to take care of these additional cows.

An Indiana farmer increased the number of chicks brooded from 400 to 2150 after electrification. No increase in labor was necessary as two electric brooders are used and water is supplied automatically to drinking fountains.

According to an Ohio farmer, electricity made it possible for him to increase his turkey flock from 11,000 to 23,000 birds. All turkeys are electrically brooded. Prior to electrification, oil was used as a source of heat for brooding and he states that he lost at least one brooder house annually by fire. Because of less labor required by electric brooders, he has been able to more than double his flock, but it was only necessary to increase his hired help from three to four and a half men.

Since electrifying his hatchery, an Indiana farmer is producing 800,000 chicks annually as compared with 350,000 before electrification. Prior to electrification, he had five 16,000 egg incubators. Hot water was used for heating the incubators, with coal as a source of heat. These have been replaced with two 66,000 egg electric incubators and two hatchers. With this automatic equipment, he has been able to more than double the output of chicks and reduce the labor from four to two men. With the electric incubators, he is securing an average hatch of 80 per cent while with the coal-heated incubators he averaged only 65 per cent. According to his report, he is also able to produce much better quality chicks with a 20 per cent higher livability and with practically no complaints from buyers.

Another Indiana farmer states that it was possible for him to increase his market hogs from 175 to 250 head annually because electricity enabled him to pipe water to the pasture. Five faucets are provided for that purpose.

It should also be noted that during this period 19 new enterprises were started by these farmers.

Even with this large increase in production the number of full-time men employed on these 41 farms decreased from 110 to 103.

The Table of Products and Conversion Factors, published in "Victory" for December 15, 1942, with definitions as set forth by the U. S. Department of Agriculture and approved by the War Manpower Commission, states that the production of 16 war units is required for classification of a farm worker as essential.

Before electrification the work on these 41 farms, exclusive of 8 men engaged in meat processing, was reported as done by 102 men (equivalent), or only 3 less than would be needed according to the "war unit" schedule.

The present reported production, exclusive of 6 men now engaged in meat processing, is the equivalent of 162 men as needed according to the "war unit" schedule; whereas only 97 men (equivalent) are reported as actually performing the farm work, or 65 less than would be needed according to the "war unit" schedule; or, on an average, one man is performing the work of 1.6 "war unit" essential men per farm.

The facts and figures are presented to point out specifically the changes taking place in the farming operations of this country. With about 2,500,000 farms receiving electric service now, and several million available to be connected after the war, there will be a market mounting into the millions of dollars for income-producing electric equipment by these farmers. To date there are only a few devices having large volume production according to the Bureau of the Census. Among these are the pressure water system, milking machine, cream separator, electric fence, and electric poultry brooder. Certainly with this progress in connecting additional farms and demands for equipment by those now being served, the number of these devices manufactured and installed on electrified farms will number hundreds of thousands of units. Then there are such items as the milk cooler, farm freezer, household dehydrator, household flour mill, egg cooler, feed grinder, feed mixer, garden irrigation equipment, milk pasteurizer, dairy barn ventilator, soil heating unit, soil sterilizer, to mention only a few of numerous other possibilities.

Manufacturers are daily approaching REA with the question, "What electric equipment can we manufacture, as soon as critical materials restrictions will be lifted and after the war, that farmers will need in quantity?" That question does not seem too difficult to answer with the long list of electric devices for the farm that have been prepared by several men engaged in rural electrification. After looking over such a list the manufacturer may decide that certain items because of his manufacturing facilities are especially

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J. P. SCHAENZER is acting head, special problems section, technical standards division, Rural Electrification Administration, U. S. Department of Agriculture.

adapted for quantity production in his plant. Then he asks, "Can you furnish me with a statement as to the market, specifications, both physical and functional, testing procedure, and other details to develop this item?" Everyone will agree that this is a most difficult question, even assuming all are agreed that there is a demand and a market for certain equipment. The possibilities for making mistakes in specifications are many and varied. That is the place where all of us have to work together. The cooperation which you have given us in the past in answering our inquiries is greatly appreciated and solicited for the future. We know that certain questions asked at times may seem strange and "cockeyed", yet they may have a definite bearing as it relates to a functional or operating specification or testing procedure. Information on fundamentals is important. That is where all of us can work together. Definitions must be established and clarified. Test procedures must be standardized and developed.

One corner of an electrified kitchen showing range and dishwasher

During the past several years we have prepared functional specifications for an electric household flour and cereal mill, for home freezer and storage chests of both 20 and 25 cu ft capacity, and an electric household dehydrator. These were approved by Technical Standards Committee "A" composed of four engineers, one each from four REA divisions. Naturally they will not approve anything which does not have all the earmarks of sound engineering and therefore requires the most thorough investigation and study before specifications are submitted. As stated previously, these specifications are of a functional nature which makes them more difficult to prepare than when specifying physical characteristics such as sheet metal, bolts, wood, etc., of definite dimensions. Functional specifications are preferred for, as a rule, we are more interested in the end product than in the mechanical process used in producing it. Nor is it desirable to hamper the initiative of the designer by specifying the method to be used, for there are always possibilities because of new inventions to accomplish the same result in another manner. The most important factor still remains, namely, will the equipment meet the requirements as determined by research and also the practical needs of the user? It should also be said that if it has no or only limited application for farmers, it has no value to REA and does not warrant spending money, effort, and time on it by manufacturers. Before endeavoring to prepare such specifications, the state agricultural colleges, U. S. Department of Agriculture, and other agencies are contacted to determine the extent of the research carried on by them. This information as secured is summarized and analyzed. All requirements are noted. These vary with every operation.

As an illustration in connection with houshold grinding of flour, questions such as the following arose and had to be answered: What shall be the capacity of the mill in pounds per hour? What grains shall it be possible to grind with it? What shall be the degree of fineness? While studying the latter, the question was raised, "How coarse can wheat or other cereal grains be ground and still have a flour from which it is possible to bake an acceptable loaf of bread?" Although all known authorities on flour milling were asked this question it is still unanswered today. Indications are that most of the research work on flour milling has been done on the fine end of the scale and practically nothing on the coarse end. Perhaps you may say that it is unnecessary to know this answer, and yet at the same time it involves a relatively simple matter and it is rather surprising at times to find out how little is known about the simple things affecting our everyday life.

In connection with writing functional specifications for a farm freezer and storage chest do you know

1 The capacity most acceptable to the largest number of farm users?

2 The optimum storage temperature and allowable temperature differential from both the point of view of keeping quality of the product and economy of operation?

3 The necessary capacity of the freezer in pounds of product to be frozen at one time and the freezing time in order to retain the quality of original product?

4 The test procedure for experimental units to determine whether or not these meet all requirements?

Household dehydrators, electrically operated, also present their standards problems as to capacity, efficiency, and testing medium. Definitions for these various factors must be established if we are to have uniformity of thinking and before it is possible to make direct comparisons of dehydrators both homemade and manufactured. Upon what shall the capacity and efficiency of the unit be based? Shall it be based upon the product dehydrated or perhaps the energy consumption per pound of water evaporated? What shall be the standard testing medium? Originally some used apples dehydrated six to one. This has very definite merit. Now some consider this procedure unsatisfactory because of the variations in moisture content and other physical characteristics of the apples. Shredded carrots are now being advocated for this purpose primarily because they are readily available throughout the entire year. Perhaps this is the best that can be done, but the question of variations again arises. As another suggestion, would it be possible to use an absorptive material which can be used over and over again without it losing its physical characteristics and will at the same time enable absorption of definite quantities of water. If such a material can be located it certainly would solve the difficulties encountered now due to the many variables of the testing mediums. The capacity and efficiency could be definitely calculated and a standard testing procedure developed and set up for universal use.

These few illustrations are cited merely to emphasize the fact that much fundamental research has still to be done before it is possible to prepare functional specifications to meet the requirements of much of the electric equipment suitable for farming and before it is ready for quantity production by manufacturers. It is a common belief in REA that general acceptance of electric equipment by farmers can best be accomplished by having such devices manufactured in quantity by reputable and reliable manufacturers, thus providing improved service, a correspondingly lower initial cost to the consumer, and having a neat streamlined appearance.

Certainly the valuable data assembled by the U. S. Department of Agriculture and the state agricultural colleges through their many years of research will serve as the foundation upon which to build the necessary standards. Much credit is due the individuals who have carried on this difficult and varied experimental work. This should not be duplicated but new problems should be tackled. Improvements should be sought for equipment in the experimental stage and that already in use. This is not easy, but it will be done in the future as it has in the past. REA is willing to help to complete the cycle in making electric equipment available to the farmers. Having no research laboratories of its own, it can only collect data and bring these together in a comprehensive form for presentation and acceptance by interested manufacturers. The fact that REA-financed lines are serving more than one million consumers has stimulated manufacturers to spend thousands of dollars in developing electric equipment for farm use and they are willing to do so in the future. Manufacturers have done this in the case of the farm freezer, electric household dehydrator, electric household flour mill, and other devices. (Continued on page 379)

Fertility Losses as a Basis for Erosion Control Planning

By J. C. Wooley
MEMBER A.S.A.E.

IN PROMOTING any program it is very helpful if some measure of its effectiveness can be established in advance. In soil conservation work with farmers we have been stressing the fact that certain crops and methods result in enormous soil losses, sometimes as much as 50 tons per acre in a single season. This seems like an enormous loss to the farmer, but it is really not in terms that he can appreciate or visualize. The productiveness of his soil, the thing he is interested in, is not measured in tons. He can allow his fields to erode until they fail to produce and he will still have tons of what he may call soil.

He needs to have the loss to his farm expressed in terms which can be measured in production, and he needs to have an evaluation of the remedies offered for solution of his problem so that he can decide what and how much to do about it. He has been told that the proper rotation of crops will solve his problem. He has heard of the benefits of strip cropping and field stripping of sod crops, of legumes, and of terracing, but he has not had a satisfactory measure of the benefits that can be derived from each of these remedies. What he wants to know is what combination of these offerings will enable him to overcome his losses and permit him to start building up his soil. Most farmers are anxious to balance their soil account, and if possible to get started on a soil building program that will make their farm better from year to year rather than to go on with a soil mining program that is sure to end finally in failure.

A. W. Klemme and O. T. Coleman of the soils department, assisted by Marion W. Clark of the agricultural engineering department of the University of Missouri worked out a plan for evaluating fertility losses from different lengths and degrees of slope under different crops, rotations, and methods of management. This plan is based on the fact that nitrogen and organic matter are very important factors in soil productivity. It is recognized that lime and other mineral plant nutrients must be kept at such a level as is suitable for biological activities and which will provide a

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Lafayette, Ind., June, 1943. A contribution of the Soil and Water Conservation Division.

J. C. WOOLEY is head, agricultural engineering department, University of Missouri.

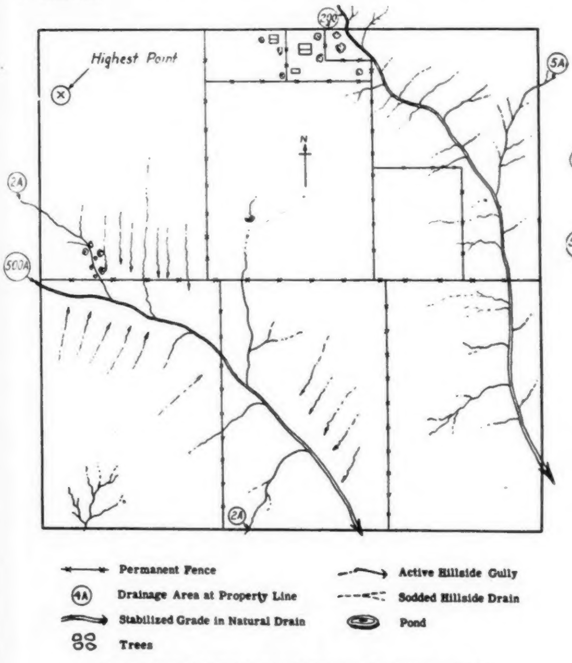

Fig. 1 Drainage and erosion pattern of a Shelby County (Mo.) farm of 160 acres before putting a water management system into effect

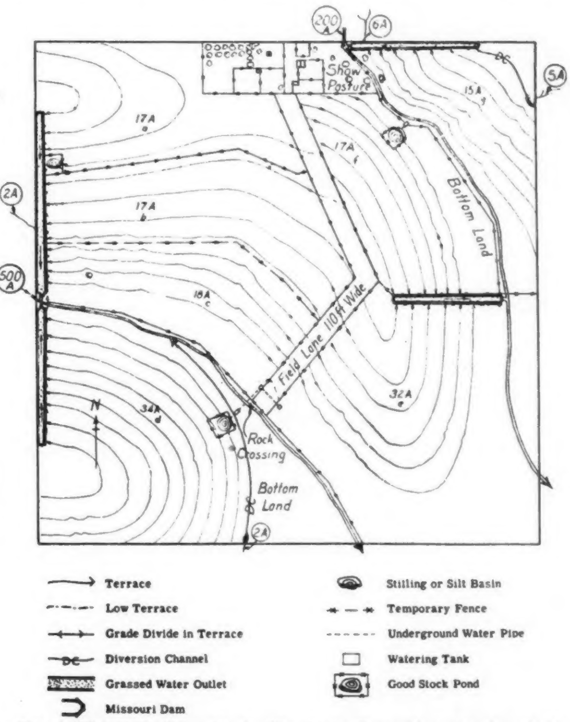

Fig. 2 The same farm (as in Fig. 1) as it would appear two to ten years later, after completing a water management system

EVALUATING SOIL CONSERVATION PRACTICES
Crop Rotation: Corn, Soybeans, Wheat, Clover-Timothy, Pasture

1	2	3	4	5	6	7	8	9		10	11	12	
Field	Acres	Avg. slope, %	Avg. length slope, ft	Mech. erosion control measure	Crops last year	Crops this year	This year's crop use	Soil Treatment Kind	Total used on field	Prod. index for crops or soil treatment	Erosion Factors	Productivity values A Pos.	B Neg.
A	25.6	3	600	None	Corn	Soys	All off	Manure	55 tons	+ .15 — .50	4.65	8.25	119.00 12.80
B	21.0	1.5	600	None	Soys	Wheat	Combined	0-20-0	3150 lb	+ .15 — .65	2.70	4.34	54.25 13.25
C	19.4	3	300	None	Pasture	Pasture	Pasture	None					
D	6.5	1	200	None	Wheat	Timothy	Hay	None		— .50			3.25
E	24.9	2	400	None	Timothy	Corn	Stalks left	Manure	5 tons	+ .15 —1.35	1.40	7.50	24.86 33.62
F	26.6	4	400	None	Pasture	Pasture	Pasture	None					
G	28.5	6	400	None	Wheat	Corn	Stalks left	None		—1.35	6.4		38.47 182.40
Total												18.09	489.00
												Difference	—471.00

Per cent loss or gain = total Column A — total Column B ÷ total Column 2.
Per cent loss = 3.14.

EVALUATING SOIL CONSERVATION PRACTICES
Crop Rotation: Corn, Soybeans, Wheat, Clover-Timothy? Pasture

1	2	3	4	5	6	7	8	9		10	11	12	
Field	Acres	Avg. slope, %	Avg. slope, ft	Mech. erosion control measure	Crops last year	Crops this year	This year's crop use	Soil Treatment Kind	Total used on field	Prod. index for crops or soil treatment	Erosion factors	Productivity values A Pos.	B Neg.
A	17	1	150	Terraced & contoured	Pasture	Corn	Stalks Past.	Manure	34	+ .15 —1.35	.20	5.10	3.40 22.95
B	17	3	100	"	Corn	Corn	Cut for fodder	Manure	34	—2.00 + .15	.65	5.10	34.00 11.05
C	18	4	100	"	Corn	Wheat	Combined	4-16-4	2700	+ .15 — .65	1.00	2.43	19.00 11.70
D	34	6	100	"	Barley & lespedeza	Barley lesp.	Combined les. past.	0-20-0	3400	+ .15 —.65, + 1.3	1.00	2.55 44.20	3.40 22.10
E	32	5	100	"	"	"	"	"	3200	+ .15, —.65 + 1.3	1.00	2.40 41.60	20.80 3.20
F	17	3	100	"	Wheat	Clover & timothy	Hay	Manure	20	+ .15		3.00	
G	15	3	100	"	Clover & timothy	Pasture	Pasture	"	20	+ .15 + .35		3.00 5.25	
Total												114.63	150.60
												Difference	— 35.97

Per cent loss or gain = total Column A — total Column B ÷ total Column 2
Per cent loss = 0.24

sufficient amount of these nutrients for optimum growth, but in the main the nitrogen content is the best measure of productivity and of soil losses.

In this plan the nitrogen removed by the crop, the nitrogen replaced to the soil by legumes, the amount added in the form of manure, the value of available commercial fertilizer as well as the losses through erosion are all accounted for.

Production Factors. Table 1 gives the gain or loss in nitrogen from various crops and different methods of using them. Corn, for example, when husked and the stalks pastured, removes 1.35 per cent of the nitrogen from the soil. If the whole crop is removed for silage, it removes 2 per cent of the nitrogen supply. Second-year alfalfa plowed under adds 3 per cent to the nitrogen content of the soil. If the hay is removed, the alfalfa sod plowed under still adds 0.5 per cent of nitrogen to the soil. Barnyard manure provides 0.15 per cent of nitrogen per acre for each ton applied;

TABLE 2.—EROSION FACTORS OR PER CENT OF NITROGEN IN SURFACE 7 INCHES OF SOIL LOST ANNUALLY FROM WATER EROSION FOR DIFFERENT CROPS OR CROPPING SYSTEMS ON DIFFERENT DEGREES AND LENGTHS OF SLOPE*

*Erosion losses for slopes of different lengths were calculated from unpublished data collected by Prof. H. H. Krusekopf of the Missouri College of Agriculture.

(Grateful acknowledgment is hereby made to Marion Clark, Extension Assistant Professor in Agricultural Engineering, who assisted in computing the erosion factors given in this table).

LAND USE METHOD	AVERAGE LENGTH OF SLOPE * Feet	CROP OR ROTATION WITHOUT CONTROL MEASURES						CROP OR ROTATION PLUS CONTOURING						CROP OR ROTATION PLUS TERRACES AND CONTOURING					
		Per Cent Slope																	
		2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
Intertilled Crops—corn, cotton, tobacco, sorghums, etc., in rows continuously for more than 1 year.	200	3.8	4.7	5.9	7.3	9.1	11.1	1.9	2.3	2.9	3.6	4.5	5.5	0.8	0.9	1.2	1.5	1.8	2.2
	400	5.9	6.7	8.0	9.4	11.1	13.1	2.9	3.3	4.0	4.7	5.5	6.5	0.8	0.9	1.2	1.5	1.8	2.2
	600	7.4	8.1	9.5	11.0	12.7	14.7	3.7	4.0	4.7	5.5	6.3	7.3	0.8	0.9	1.2	1.5	1.8	2.2
	800	8.7	9.4	10.8	12.3	14.0	15.9	4.3	4.7	5.4	6.1	7.0	7.9	0.8	0.9	1.2	1.5	1.8	2.2
	1000	9.8	10.6	12.0	13.4	15.1	17.1	4.9	5.3	6.0	6.7	7.5	8.5	0.8	0.9	1.2	1.5	1.8	2.2
	1200	10.9	11.6	12.9	14.4	16.2	18.1	5.4	5.8	6.4	7.2	8.1	9.0	0.8	0.9	1.2	1.5	1.8	2.2
Intertilled Crops after small grain, sudan, soybeans, etc.—drilled solid, not grown in rotation with sod legumes or grasses.	200	3.0	3.7	4.7	5.8	7.3	8.9	1.5	1.8	2.3	2.9	3.6	4.4	0.6	0.7	0.9	1.1	1.4	1.7
	400	4.7	5.3	6.4	7.5	8.9	10.5	2.3	2.6	3.2	3.7	4.4	5.2	0.6	0.7	0.9	1.1	1.4	1.7
	600	5.9	6.5	7.6	8.8	10.1	11.7	2.9	3.2	3.8	4.4	5.0	5.8	0.6	0.7	0.9	1.1	1.4	1.7
	800	7.0	7.5	8.6	9.8	11.2	12.7	3.5	3.7	4.3	4.9	5.6	6.3	0.6	0.7	0.9	1.1	1.4	1.7
	1000	7.8	8.5	9.6	10.7	12.1	13.7	3.9	4.2	4.8	5.3	6.0	6.8	0.6	0.7	0.9	1.1	1.4	1.7
	1200	8.7	9.3	10.3	11.5	13.0	14.5	4.3	4.6	5.1	5.7	6.5	7.2	0.6	0.7	0.9	1.1	1.4	1.7
Intertilled Crops—corn, cotton, tobacco, etc., after clover, alfalfa, lespedeza or permanent grasses.	200	0.9	1.1	1.6	2.5	4.0	6.0	0.4	0.5	0.8	1.2	2.0	3.0	0.2	0.2	0.3	0.5	0.8	1.2
	400	1.4	1.6	2.2	3.1	4.5	6.6	0.7	0.8	1.1	1.5	2.2	3.3	0.2	0.2	0.3	0.5	0.8	1.2
	600	2.2	2.4	2.9	3.8	5.2	7.3	1.1	1.2	1.4	1.9	2.6	3.6	0.2	0.2	0.3	0.5	0.8	1.2
	800	3.0	3.2	3.7	4.6	6.1	8.1	1.5	1.6	1.8	2.3	3.0	4.0	0.2	0.2	0.3	0.5	0.8	1.2
	1000	3.9	4.1	4.7	5.6	7.0	9.1	1.9	2.0	2.3	2.8	3.5	4.5	0.2	0.2	0.3	0.5	0.8	1.2
	1200	5.0	5.2	5.7	6.7	8.0	10.1	2.5	2.6	2.8	3.3	4.2	5.0	0.2	0.2	0.3	0.5	0.8	1.2
Small Grains after intertilled crops—not grown in rotation with sod legumes or permanent grasses.	200	2.3	2.8	3.5	4.4	5.5	6.7	1.1	1.4	1.7	2.2	2.4	3.3	0.5	0.6	0.7	0.9	1.1	1.3
	400	3.5	4.0	4.8	5.6	6.6	7.8	1.7	2.0	2.4	2.8	3.3	3.9	0.5	0.6	0.7	0.9	1.1	1.3
	600	4.4	4.9	5.7	6.6	7.6	8.7	2.2	2.4	2.8	3.3	3.8	4.3	0.5	0.6	0.7	0.9	1.1	1.3
	800	5.2	5.6	6.5	7.4	8.4	9.5	2.6	2.8	3.2	3.7	4.2	4.7	0.5	0.6	0.7	0.9	1.1	1.3
	1000	5.9	6.3	7.2	8.0	9.0	10.2	2.9	3.1	3.6	4.0	4.5	5.1	0.5	0.6	0.7	0.9	1.1	1.3
	1200	6.5	7.0	7.7	8.6	9.7	10.9	3.2	3.5	3.8	4.3	4.8	5.4	0.5	0.6	0.7	0.9	1.1	1.3
Small Grains after intertilled crops grown in rotation with sod legumes or permanent grasses.	200	0.6	0.7	1.1	1.9	3.5	6.3	0.3	0.4	0.5	0.9	1.7	3.1	0.1	0.1	0.2	0.4	0.7	1.2
	400	1.1	1.2	1.6	2.5	4.0	6.9	0.5	0.6	0.8	1.2	2.0	3.4	0.1	0.1	0.2	0.4	0.7	1.2
	600	1.8	1.9	2.3	3.2	4.8	7.5	0.9	0.9	1.1	1.6	2.4	3.7	0.1	0.1	0.2	0.4	0.7	1.2
	800	2.6	2.7	3.1	4.0	5.6	8.4	1.3	1.3	1.5	2.0	2.8	4.2	0.1	0.1	0.2	0.4	0.7	1.2
	1000	3.6	3.7	4.0	4.9	6.6	9.4	1.8	1.8	2.0	2.4	3.3	4.7	0.1	0.1	0.2	0.4	0.7	1.2
	1200	4.6	4.7	5.1	5.9	7.7	10.3	2.3	2.3	2.5	2.9	3.8	5.1	0.1	0.1	0.2	0.4	0.7	1.2
Small Grains after small grains, soybeans, cowpeas, sudan or sorghums—drilled solid.	200	1.9	2.3	2.9	3.6	4.5	5.5	0.9	1.2	1.5	1.8	2.3	2.8	0.4	0.5	0.6	0.7	0.9	1.1
	400	2.9	3.3	4.0	4.7	5.5	6.5	1.5	1.7	2.0	2.3	2.8	3.3	0.4	0.5	0.6	0.7	0.9	1.1
	600	3.7	4.0	4.7	5.5	6.3	7.3	1.8	2.0	2.4	2.7	3.2	3.7	0.4	0.5	0.6	0.7	0.9	1.1
	800	4.3	4.7	5.4	6.1	7.0	7.9	2.2	2.3	2.7	3.2	3.5	4.0	0.4	0.5	0.6	0.7	0.9	1.1
	1000	4.9	5.3	6.0	6.7	7.5	8.5	2.4	2.6	3.0	3.3	3.8	4.3	0.4	0.5	0.6	0.7	0.9	1.1
	1200	5.4	5.8	6.4	7.2	8.1	9.0	2.7	2.9	3.2	3.6	4.0	4.5	0.4	0.5	0.6	0.7	0.9	1.1
Small Grains after clovers, alfalfa, lespedeza or permanent grasses—or lespedeza grown alone.	200	0.2	0.4	0.7	1.1	2.1	3.7	0.1	0.2	0.3	0.5	1.0	1.8	0.1	0.1	0.1	0.2	0.4	0.7
	400	0.6	0.7	1.0	1.5	2.4	4.1	0.3	0.3	0.5	0.7	1.2	2.0	0.1	0.1	0.1	0.2	0.4	0.7
	600	1.0	1.1	1.4	1.9	2.8	4.5	0.5	0.5	0.7	0.9	1.4	2.2	0.1	0.1	0.1	0.2	0.4	0.7
	800	1.5	1.6	1.9	2.4	3.3	5.0	0.7	0.8	0.9	1.2	1.6	2.5	0.1	0.1	0.1	0.2	0.4	0.7
	1000	2.1	2.2	2.4	2.9	3.9	5.6	1.0	1.1	1.2	1.4	1.9	2.8	0.1	0.1	0.1	0.2	0.4	0.7
	1200	2.7	2.8	3.1	3.5	4.6	6.2	1.3	1.4	1.5	1.7	2.3	3.1	0.1	0.1	0.1	0.2	0.4	0.7
Legumes and Grasses—heavy stands and growth of clovers, or alfalfa, or mixtures of same with or without lespedeza, or grasses, or both.	200	0.2	0.3	0.3	0.4	0.6	1.1	0.1	0.1	0.1	0.2	0.3	0.5	0.0	0.0	0.0	0.0	0.1	0.2
	400	0.3	0.4	0.5	0.6	0.9	1.2	0.1	0.2	0.2	0.3	0.4	0.6	0.0	0.0	0.0	0.0	0.1	0.2
	600	0.4	0.5	0.6	0.8	1.1	1.4	0.2	0.3	0.3	0.4	0.5	0.7	0.0	0.0	0.0	0.0	0.1	0.2
	800	0.6	0.7	0.8	0.9	1.2	1.5	0.3	0.3	0.4	0.5	0.6	0.8	0.0	0.0	0.0	0.0	0.1	0.2
	1000	0.8	0.9	1.0	1.2	1.4	1.7	0.4	0.4	0.5	0.6	0.7	0.9	0.0	0.0	0.0	0.0	0.1	0.2
	1200	1.0	1.2	1.3	1.4	1.6	2.0	0.5	0.6	0.6	0.7	0.8	1.0	0.0	0.0	0.0	0.0	0.1	0.2
Well-sodded meadows or pastures.	Entire Slope	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Well-sodded, but overgrazed pastures and meadows.	Entire Slope	0.5	0.5	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0

1. Bare or fallow land free of vegetation will have erosion factors about double those given for intertilled crops. Idle land covered with weeds, erodes about one-fourth to one-half as much as continuous intertilled crops.

2. Where terraces are used on land commonly used for intertilled crops or small grains, without the benefit of legumes and grasses in the rotation, their maintenance cost becomes excessive (making them impractical).

3. The erosion factors in Table 9 for terraced land, are based on experimental evidence which shows that properly constructed terraces with stable outlets can be expected to reduce erosion an average of about 80 per cent. On short gentle slopes, terraces will not reach this degree of effectiveness, while on longer slopes their effectiveness will exceed 80 per cent.

4. The erosion factors for contouring are also based on experimental evidence which shows that this practice when considered for the entire year (on the average Missouri soil) can be expected to reduce erosion at least 50 per cent under that of the crop rotation alone. On the more gentle slopes of the open porous soil, this practice will likely exceed 50 per cent in effectiveness while on the impervious clay pan soils, it may be slightly under 50 per cent in effectiveness.

5. Strip cropping with contouring (where applicable) or contouring plus well-established buffer strips should be given erosion factors about half way between crop rotations plus contouring and crop rotations plus terraces and contouring.

6. Where slopes are over 12 per cent or longer than 1200 feet, the factors should be increased in the same ratio as those listed for the more moderate or shorter slopes.

commercial fertilizer 0.15 per cent for each 40 lb of available nutrients.

TABLE 1. PER CENT OF TOTAL NITROGEN GAINED OR LOST ANNUALLY FOR THE VARIOUS CROPS AND METHODS OF UTILIZING THEM

CROPS (Productivity indexes given are for full stand and normal growth. One-half full crop means one-half the index listed, etc.)	All turned under or left on land	Grazed off or grain or seed only removed	Whole crop removed or burned
1. Grasses			
Permanent pastures	0.00	0.00	—0.50
Perennial grasses	0.00	0.00	—0.50
Perennial grasses, + 50% legumes	+0.50	+0.35	0.00
Sudan grass	0.00	—0.50	—2.00
2 Intertilled Crops			
Corn, tobacco, sorghums, etc.	0.00	—1.35	—2.00
Cotton	0.00	Lint & seed —1.35	—2.00
3 Legumes (When well inoculated)			
Alfalfa—over 1 year old	+3.00	+2.25	—0.50
Alfalfa—under 1 year old	+1.00	+0.75	0.00
Clover, alsike — 1st year	+0.75	+0.50	0.00
Clover, alsike — 2nd year	+1.75	+1.30	0.00
Clover, red — 1st year	+1.00	+0.75	0.00
Clover, red — 2nd year, 1st crop	+2.00	+1.50	+0.25
Clover, red — 2nd year, 2nd crop	+0.50	+0.35	0.00
Clover, crimson-spring after seeding	+1.50	+1.00	0.00
Clover, sweet — 1st year	+1.00	+0.75	0.00
Clover, sweet — 2nd year	+3.00	+2.25	+0.50
Lespedeza — crop growth to Aug. 1	+1.00	+0.75	0.00
Lespedeza — crop growth after Aug 1	+0.75	+0.50	0.00
Lespedeza — total season crop	+1.75	+1.30	0.00
Soybeans, cowpeas, etc.	+1.00	+0.75	—0.50
Vetch, winter	+1.50	+1.00	—0.50
4 Small Grains		Combined—0.65	
Wheat, oats, rye, barley, flax, etc.	0.00	Grazed —0.25	—1.00
5 Soil Treatments			
Barnyard or straw manure per ton applied			+0.15
Commercial fertilizer, for each 40 lb available plant food applied			+0.15

All crops turned under, grazed, or removed from the land during the season should receive consideration.

Heavy applications of straw or other organic matter low in protein without the growth of legumes on the land or the use of chemical treatments may cause a temporary reduction in available nitrogen.

Each ton of feed hauled to the farm and fed in the fields and not otherwise given credit as manure should be given credit equivalent in barnyard manure as follows: Small grain straw or silage, 0.5 tons; timothy, orchard grass, red top, sorghums, corn fodder, etc. (air dry), 1.5 tons; legumes, grains, grain mixtures and supplementary feeds, 3.0 tons.

Erosion Factors. In Table 2 the per cent of nitrogen lost through erosion on different lengths and degrees of slope and under different crops and systems of management are given. For example, the loss on corn on a 6 per cent slope, 800 ft long, would be 10.8 per cent annually. This same field if planted on the contour would lose 5.4 per cent, and if terraced and farmed with the terraces, 1.56 per cent of the nitrogen annually. In arriving at these figures, contouring is credited with reducing erosion 50 per cent. If a field is contoured correctly the benefits may exceed this amount, but if the contouring is done without an accurate survey the benefits may be far below the 50 per cent allowed. Terracing and contour farming combined are credited with reducing erosion losses 85 per cent. Here again we have a variation. In some of the experimental fields the effectiveness has been as much as 92 per cent, but again we have evidence that terracing and contour farming without proper soil management would fall far below the 85 per cent in effectiveness. It is interesting to note that corn following a legume in the rotation on this 6 per cent slope, 800 ft long, would lose 3.7 per cent if not contoured, 1.85 per cent if contoured, and 0.54 per cent if terraced and contoured.

It is evident from these figures that the solution of the erosion problem is a combination of agronomic and engineering practices rather than either alone.

In order to illustrate the use of this information and to show its significance in planning an erosion control program for a farm, I will carry through the plan on a 160-acre farm. This farm is located in northwest Missouri on Shelby soil. Fig. 1 shows the farm before planning.* The rotation followed was corn, soybeans, wheat, hay, and pasture. One hundred-five tons of manure were spread on the fields each year. Fields were plowed and planted with the boundaries. This was not a bad system of management as farming goes in that section, and yet the soil was being depleted at the rate of 3.14 per cent per year. This would cause abandonment in less than 32 years unless some change in management was made.

Computation of Fertility Balance. Field A, 25.6 acres, 3 per cent slope, 600 ft long, was planted to soybeans following corn. Fifty-five tons of manure were added during the year. The production factor for the manure (Table 1) was 0.15 per cent per ton making 8.25 in the positive column. Soybeans following corn had a production factor of –.50 per acre. This gives a negative production factor of 12.8 and is placed in the negative column. The erosion factor for the 3 per cent, 600-ft slope with soybeans following corn is 4.65 per cent, and 4.65 x 25.6 acres gives 119.0 which goes in the negative column. Erosion loss was almost ten times that removed in the crop.

Field B is figured in a similar manner except for the commercial fertilizer (3150 lb, of which 20 per cent is available, equals 630 lb of available nutrients). For each 40 lb of available nutrients, 0.15 per cent is allowed, and 630/40 x .15 = 2.34 which is placed in the positive column. The difference between the positive and negative columns divided by the total acres gives the per cent depletion or building each year.

Fig. 2 shows the same farm replanned with terraces and with the fields arranged for contour farming. The rotation followed in the main was corn, corn, wheat, clover and timothy, and pasture, with two fields in barley and lespedeza each year. With all these methods we find that we are still on the negative side of the ledger to the extent of –0.24 per cent in our fertility account. We are still taking out more than we are putting back. A glance at the figures shows that field B is being depleted too rapidly and that it will be necessary to eliminate one year of corn in the rotation. If this is done, the farm can be started on a building rather than on a depleting program. Hundreds of farmers in Missouri have applied this test to their farms themselves and in many cases they have started on a plan for real improvement.

The authors of this plan do not claim that it is 100 per cent correct for all conditions. However, if anyone will take each of the production and erosion factors and check them against experimental data, he will have a great deal of respect for the accuracy of the plan. I feel that anyone who is planning farms will find this to be very valuable aid to his work.

The thing that impresses me most is the need for cooperation in the solution of the problem. The engineer must plan the farm for the management of runoff water and the agronomist for building up the fertility of the soil. Neither one alone can balance the farmer's soil account, but both working together can show farmers how to cease borrowing from the future and go on a program of good business in soil management.

*Farm plans taken from Missouri Ag. Exp. Sta. Circular 433, "Water Management".

Farm Needs in Electric Equipment

(Continued from page 376)

This was forcefully demonstrated recently when the government gave approval for manufacturing 100,000 dehydrators. The developmental work had been completed by several manufacturers and they were ready to set up a production line. This was no accident, but only made possible through the cooperation of many individuals, agencies, and manufacturers. The processing of this program is not only a challenge to us engaged in research, extension, promotion, education, equipment development, and other phases of rural electrification, but also an obligation we owe to the farmers of this country in providing them with the best electric income-producing equipment that we know how. For the present, perhaps, our efforts should primarily be devoted to such equipment required for food production, conservation and preservation. When we return to peace, time can again be given to those devices classed in the luxury and semi-luxury group.

In conclusion it should be said that an excellent start has been made in establishing definitions for capacities and efficiencies as well as developing standards and testing procedures, by everyone giving his support to each specific problem. A tremendous job still lies ahead in doing the same for the many devices still in a nebular stage of development. Greater progress is expected in the future based upon the complete cooperation and coordination of efforts, with all working for a common goal, a better and fuller life for the American farmer.

REFERENCES

Rural Electrification Engineering and Electro-Agricultural Engineering by M. M. Samuels, Electrical Engineering, April 1943.

New Engineering and a New Industry by M. M. Samuels, Electrical Engineering, October 1942.

New Ideas in Rural Electrification Engineering by M. M. Samuels, AGRICULTURAL ENGINEERING, March 1941.

More Farm Ponds Needed

By Howard Matson
MEMBER A.S.A.E.

IN LARGE sections of this country ponds are the chief source of livestock water supply for farms or ranches. Many of these ponds also provide water for irrigation or for farmstead uses, and may be utilized for fish production and recreational purposes. Probably there are more than a million farm and ranch ponds in existence today, but it should not be assumed that there is no longer a need for the services of agricultural engineers in designing and constructing ponds and reservoirs.

Additional ponds are still needed in many pasture and range areas to make possible a more efficient utilization of the available forage. In some cases good grass areas are so far from a watering place that they are grazed very lightly, if at all, while the grass near ponds or watering tanks is grazed too closely and heavily trampled. Many range areas would produce more available forage if they were cross-fenced to make it possible to rotate the grazing among several pastures. This would facilitate the maximum utilization of seasonal vegetation on each pasture, and the rest periods would give better grasses an opportunity to improve their stands. Although such a practice is desirable, many ponds and other sources of water will be needed before it can be widely adopted.

Many thousands of acres of land are still being cropped which are so steep or so severely eroded that they cannot be continued in cultivation, even with the best conservation practices we know, without further damage to the land. Thousands of acres of other land, particularly in the South, which once were cultivated have now been abandoned and are covered with bushes, weeds, and poor grasses which afford very little grazing. Trees should be planted on part of these two types of land, but the greater part should be developed into pasture. The use of these lands for pasture will require the provision of additional watering facilities.

In the semiarid and arid sections there is an opportunity for a much greater use of ponds as a source of water for irrigation. Even a relatively small pond can supply enough water for the irrigation of a garden, and if a large pond capacity is feasible there may be enough water to irrigate feed crops or even field crops.

The meat shortages which we are experiencing during wartime are arousing widespread interest in the use of ponds for fish production as a supplement to other kinds of meat. A pond which is properly constructed, fertilized, stocked, and managed will produce as much as 500 pounds of fish annually for each acre of surface area.

In addition to these needs for many new ponds, a large proportion of the existing ponds need to be enlarged, deepened, or otherwise improved to provide a dependable source of water supply or to make them suitable for additional uses. Every year in some parts of the country farmers are hauling water for home use and for livestock.

Many farmers and other persons fail to realize the need for the services of an agricultural engineer in connection with the planning and building of a farm pond. It seems a simple matter to scoop out some dirt and pile up a fill across a waterway or gully — and it is. But if the pond is small it may go dry just when water is most needed; if it is large, it may never be filled; it may not hold water more than a few days because of seepage, or the runoff from the first big rain may wash it out. We have seen these things happen many times, but we know that by careful planning and construction they can be avoided.

As an aid in developing an appreciation of the necessity for adequate planning for farm pond construction, an outline follows which lists the most important things that need to be considered in planning a pond. More ponds are needed; better ponds are needed; and it is a job for agricultural engineers:

CONSIDERATIONS IN PLANNING FARM PONDS

1 Select the pond site
  (a) In pasture or range area, located to afford efficient utilization of available forage
  (b) Drainage area mostly in pasture or woods to prevent excessive silting
  (c) Soil conditions suitable for pond construction. (Check by borings)
  (d) Length of dam short as possible
  (e) Dam can be built high enough (or excavation can be made deep enough) to give adequate depth of water
  (f) Suitable spillway site is essential
  (g) Suitable fill material is essential.
2 Determine the size and shape of the drainage area and its physical characteristics
  (a) Predominant slopes and soil types
  (b) Types and distribution of cover and land use
  (c) Extent and nature of erosion.
3 Determine the probable minimum annual yield which can be dependably expected from the tributary watershed
  (a) Consider the characteristics of the watershed and all available rainfall and runoff data applicable to the vicinity.
4 Determine the desirable ratio between drainage area and storage capacity
  (a) If too large, silting will be too rapid and there will be flow through the spillway too much of the time
  (b) If too small, the water supply will not be dependable unless a greater depth of water than usual is provided.
5 Estimate use requirements
  (a) Livestock
  (b) Irrigation
  (c) Farmstead water supply.
6 Estimate annual loss by evaporation.
7 Determine the minimum depth which must be provided over what area to assure an adequate supply of water during extended periods of low rainfall
  (a) Make allowance for necessary added depth to compensate for the expected rate of silting, and for seepage losses.
8 Determine the storage capacity of the pond for the proposed fill height
  (a) If necessary, plan diversion terraces to increase or decrease the watershed area of the pond to obtain a desirable drainage area to storage capacity ratio.
9 Estimate the maximum rate of runoff to be expected. (For outlet design)
  (a) Consider the watershed characteristics as determined under No. 2 above
  (b) Consider available precipitation data for the vicinity
  (c) Consider hydrographs of runoff from nearby similar watersheds, if available
  (d) Consider pertinent experiment station or watershed runoff study data.
10 Select the type of outlet to be used
  (a) An open channel spillway at one end of the dam is usually the most practical and economical
  (b) An overfall or drop inlet type structure may be necessary if there is no practical location available for an open spillway.
11 Design the spillway or other outlet
  (a) An open channel spillway protected by vegetation is the most economical where adequate protection can be afforded
  (b) All turning of the direction of flow of water in spillways should be accomplished at velocities of flow less than critical velocity and depths greater than critical depths
  (c) If a drop inlet culvert, overfall structure, or lined spillway must be used to carry normal flows, expense may be saved by providing a vegetated emergency spillway to carry part of the peak flows
  (d) If a drop inlet culvert or overfall structure is used, adequate provision must be made for the dissipation of energy of flow to prevent undermining of the structure and erosion of the outlet channel.
12 Plan core wall, if needed
  (a) Experience indicates that a thoroughly compacted core wall of impervious soil material should be used in all earth dams to eliminate seepage which might result from an inadequate bonding of the fill material with the natural ground. (Continued on page 382)

A preliminary report of the Subcommittee on Ponds and Reservoirs (Howard Matson, chairman), Soil and Water Conservation Division, American Society of Agricultural Engineers.

HOWARD MATSON is chief, engineering division (Region 4), Soil Conservation Service, U. S. Department of Agriculture.

Forced Ventilation of High Moisture Grains

By G. R. Shier, R. C. Miller, and W. A. Junnila
MEMBER A.S.A.E. MEMBER A.S.A.E. MEMBER A.S.A.E.

IT IS common knowledge that the rapid increase in soybean production has created acute problems in harvesting and storage. Large acreage increases in areas where combines were few made it a foregone conclusion that many beans would be harvested with high moisture content or not harvested at all.

At Ohio State University we have not carried on ventilation studies with soybeans; however, a number of farmers have been doing it in their seed corn driers. Dr. Miller, of Mount Vernon, grows edible soybeans. Last year he grew over 400 acres, mostly on contract with growers of hybrid seed corn. These men combined and bagged the beans and placed the sacks of beans in their seed corn bins. Most of the beans were harvested ahead of the seed corn during favorable weather, but the moisture content was too high and too unevenly distributed for safe bean storage. The bagged beans were ventilated in the seed corn bins without heat or with only a small amount of heat. Dr. Miller has found the seed corn driers so satisfactory for drying his beans that he is now constructing a seed corn type drier at his plant solely for the purpose of drying beans in bags.

High moisture beans do not spoil if they can be kept cool until they are dried or consumed. Although little information has been available on the curing of beans, considerable work is now being done, and much of the work done with other high moisture crops can be used as a basis for bean storage requirements.

Ventilation and curing of high moisture grain is not new. In recent years Kelly, Barre, Burkhardt, and Fenton have reported on the fundamentals of ventilation and moisture removal upon several occasions[1].

From evidence gathered in our own studies[2] and by these men and others, it seems certain that only in unusually favorable seasons will such crops as corn, grain sorghums, and soybeans go into the bin at moisture contents of 14 per cent or below. In the case of grains that are stored cool and fed or milled before warm weather in the spring, high moisture may not necessarily cause spoilage since temperatures below 50 deg apparently discourage growth of mold in grains containing no more than 17 or 18 per cent moisture.

Climatic conditions during the winter season throughout the corn belt are such that high moisture grain will stabilize at moisture content between 16 and 20 per cent. Grain that was dry when stored in the fall may increase in moisture unless protected by vapor barriers and closed off from ventilation.

What the farmer appears to need is a foolproof grain storage into which he can place any kind of grain at any season and make certain that it will not spoil. In our own work we have assumed that two of the requirements of such a storage will be forced ventilation and bins that can be closed when necessary.

In the fall of 1940 several agencies[3] made equipment and materials available; and in cooperation with the Ohio State University farm, we began to study the forced ventilation of grain with high moisture corn which had been harvested with a picker-sheller combine.

The first year we operated three bins. One was equipped with a hardware cloth floor, and it was filled to a depth of 3 ft with high moisture corn. It was a 10-ft circular metal bin, and ventilation was by means of a No. 1½ Siroco blower which furnished 800 cfm, or about 10 cfm per sq ft of floor area. This study indicated that although hardware cloth permitted excellent ventilation, it was too easily damaged to be very satisfactory. It also established the fact that the amount and distribution of air was sufficient to give uniform temperature changes through all parts of the grain. This change in temperature obtained by ventilating continuously night and day is very important in drying with unheated air.

The second bin was a rectangular bin in the hog barn. It was lined with plywood and equipped with a perforated metal floor containing slots ¼ in wide and 1½ in long. The slots provided about 3 per cent openings in the total floor area. These perforations were intended for ear corn and not for shelled corn or small grain, so a small amount of corn fell through the perforations. The metal sheets were joined by flat seams similar to those used in laying flat metal roofs, and the result has been very satisfactory, although smaller perforations giving about the same opening would be more desirable in retaining grain. This bin has been used for three seasons, and it has been filled up to six or seven feet depth and emptied many times. The air forced through the bin could be raised in temperature about 20 deg by steam coils in an adjoining room. This in no case through the winter gave a temperature in the bin higher than 55 deg, and usually the temperature was in the forties. Approximately 30 cfm of air per square foot of floor was used in this bin. Static pressure under the bin was 15 mm of water for 4½ ft of corn.

The 20-deg temperature rise cut the high winter relative humidity in half, and the corn dried down to 9 or 10 per cent moisture. Drying started in the bottom of the bin where the air entered. With 20 per cent moisture in the corn, the drying zone progressed upward at a rate of about six inches per day. The moisture carried up from below exposed the corn in the top of the bin to a high relative humidity. The upper corn assumed a moisture content of about 20 per cent. As mentioned, the temperature did not exceed 55 deg in the top of the bin, and no visible or observed spoilage occurred in the corn which was later fed. In the three years during which this bin has been operated, it has given the swine department a great deal of satisfaction because it enables them to purchase high moisture corn, which is often the only kind available, and safely reduce it to a moisture content that will permit grinding and storage during the winter without the hazard of the feed becoming musty.

A portable test bin, about 4x4x8 ft high, was equipped with a hardware cloth floor and filled with about 100 bu of 20 per cent moisture corn. This bin was operated in a laboratory where the temperature of the air was between 70 and 80 deg and the relative humidity was very low because outside temperatures were normally at least 40 deg lower than in the laboratory. A small blower forced about 30 cu ft of air per minute per square foot of floor through the bin. Due to the high temperature and low relative humidity, the heat exchange in the corn caused a 25 to 30-deg temperature drop. The air escaping from the top of the bin was naturally saturated but did not exceed a temperature of 55 deg. The corn in the top of the bin contained 20 per cent moisture and was exposed to saturated air at 55 deg for 10 days but did not develop any sign of spoilage or a musty odor. This corn also dropped to about 9 per cent moisture.

These studies convinced us that it was possible to prevent spoilage in high moisture grain during cool weather by ventilating with a moderate amount of air, and if a small amount of heat is added, it can be dried under winter air conditions.

In 1941 the hardware cloth floor in the metal bin was removed and a ¼-in plywood floor substituted. Slots were cut in the plywood by a portable power-driven hand saw. They provided about 3 per cent opening in the floor. A fan was put on the bin, and about 5 ft of corn, ranging from 17 to 18½ per cent moisture, was kept at temperatures around and below 30 deg until the first of the year when during a cold snap the corn was cooled to approximately 0 F. From then on no ventilation was given until the last week of April. Frequent temperature observation showed that the corn was gradually warming up. On April 16 the moisture content of the corn ranged from 15.6 to 17.9 per cent, being the highest in the top of the bin. Ventilation in the fall had removed a slight amount

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G. R. SHIER formerly extension agricultural engineer, Ohio State University, is associated with Howard L. Sterner Co., consulting structural engineers. R. C. MILLER is professor of agricultural engineering, and W. A. JUNNILA instructor in rural electrification, Ohio State University.

[1]H. J. Barre, AGRICULTURAL ENGINEERING, June 1938; C. F. Kelly, AGRICULTURAL ENGINEERING, April 1939, December 1940; Geo. J. Burkhardt, AGRICULTURAL ENGINEERING, December 1940; F. C. Fenton, AGRICULTURAL ENGINEERING, May 1941, and H. J. Barre and C. F. Kelly, AGRICULTURAL ENGINEERING, March 1942.

[2]Bimonthly Bulletin No. 220, Ohio Agricultural Experiment Station.

[3]Cooperators were J. D. Long, P. W. Keating, and Carl Oberlin, who supplied plywood, metal bins, and perforated sheets, respectively.

of moisture but not enough to make the corn safe in warm weather.

During the last week of April and the first week of May, favorable weather for drying occurred, and the corn was ventilated night and day for 13 days with only a few short interludes when the fan was stopped during rain showers. About 600 cfm were measured escaping from the top of the bin. The corn rapidly dropped in moisture content to 11.8 per cent in the bottom and 14.5 per cent in the top. The fan was removed, and the corn was left in the bin until October, when it was removed in excellent condition at a moisture content of 12 per cent and no sign of spoilage or insect infestation.

In the fall of 1942, over 2,000 bu of high moisture corn were combined. Having had considerable experience with the flues used in barn curing of hay[4], we determined to install flues of that type in another 10-ft round metal bin. This was done, and this bin was filled with 8 ft of corn ranging from 17 to 18.3 per cent moisture. No forced ventilation was given until the last of April when a fan was connected. By that time corn in the top of the bin, which was close to the roof, had begun to heat and mold. The fan cooled the corn and spoilage ceased. The weather was persistently warm and damp so that it was not possible to dry the corn rapidly. The fan was operated when the weather was cool and dry. The corn gradually lost moisture although the month of May (1943) was the most unfavorable for many years being persistently wet and warm.

The best rule of thumb index of when the corn will dry is generally to operate the fan at those times when the weather favors drying up moisture in the soil. During periods of sharp temperature differences between night and day, fans using unheated air should operate continuously to take advantage of the favorable heat exchange and relative humidity conditions. If the temperature remains constant for any prolonged period, ventilation seldom removes moisture.

The principal problem facing the farmer who attempts to use forced ventilation in his grain bins is the method of distributing the air. The perforated floors are very satisfactory but consume considerable bin capacity and provide a shelter for rats and mice. The limited tests made during the past season with three-sided flues resting on slats a couple of inches above the bin floor indicate that they have practical possibilities since they can be laid on the floor of any grain bin and connected to a small blower. Excellent small blowers were available prior to America's entry into the war, but at present they are difficult to obtain. The blower for grain ventilation must be able to produce the desired amount of air at static pressures up to or exceeding one inch resistance.

As a blower was needed to produce about 500 cfm, we constructed a 10-in radial-bladed rotor from $\frac{1}{4}$-in Ext. D.F.P.A. plywood for sides and twelve $\frac{3}{8}$ x 5 x 1$\frac{3}{4}$-in wooden vanes. The rotor was fastened together with nails driven through the plywood into the ends of the vanes. A suitable housing was constructed, and the rotor was mounted on the shaft of a $\frac{1}{4}$-hp motor. When operating it drew slightly less current than the rating for the motor. A fan of this type is light and portable and easily carried from one bin to another.

A plywoood blower containing a 24-in rotor was constructed and has been used for two seasons. It has given excellent service, and with reasonable care should last many years.

The development of satisfactory lightweight portable blowers for use with fractional horsepower motors will go a long way toward helping solve the problem of reducing spoilage of high moisture grain in farm bins. In Ohio more than two-thirds of the farms have electric service, and the grain could readily be ventilated if suitable blowers were available.

[4]R. C. Miller and G. R. Shier, AGRICULTURAL ENGINEERING, May 1943.

More Farm Ponds Needed

(Continued from page 380)

(b) Sheet piling is expensive and is ineffective as a substitute for a well-compacted clay core unless of the interlocking type and expertly placed under favorable soil conditions. Should never be used except to meet special conditions in connection with large dams.

(c) Where needed, a hardware cloth barrier placed along the upper side of the core wall and extending to the top of the dam has been found effective in preventing rodent damage to earth fills.

13 Provide for flow from perennial or seasonal springs, if the spillway is protected by vegetation

(a) Trickle channels are not satisfactory if soil is subject to cracking, or to heaving due to frost action

(b) Where necessary, a pipe of adequate size should be installed through the fill, with concrete collars to prevent seepage, and the riser should extend up only to a point 6 to 8 in below the spillway crest so that wave action will not keep a small flow going through a vegetative spillway.

14 Plan riprap protection if needed

(a) Need for riprap is dependent upon (1) shape and surface area of pond, (2) protection from wind afforded by surrounding hills and trees, (3) direction of the axis of dam with relation to prevailing winds, and (4) effectiveness of available vegetation as a protection against wave action.

(b) If riprap is necessary, use large durable stone placed on a gravel blanket. Gravel particles must be of sufficient size not to be washed away by wave action. Place riprap from the toe to the top of the fill.

(c) Where vegetative protection is insufficient but no satisfactory native riprap materials are available, plan a flatter slope for the upper face of the fill. Booms, wooden fences or piling, etc., as substitutes for riprap are usually unsatisfactory and temporary.

15 Plan for mosquito control, if proposed pond is in a locality where malaria is prevalent. (Required in some states)

(a) Clear pond margins of trees, stumps, and debris

(b) Reduce amount of shallow area, if possible

(c) Provide a pipe through the dam of sufficient size to permit fluctuation of the pond water level as required.

16 Provide for protection of the pond from livestock, and for stock watering facilities

(a) Pipe through the dam or siphon over the fill should not be less than 2 in in diameter

(b) Concrete, masonry, or metal watering trough or troughs below the dam should be equipped with float valves to maintain a full supply of water

(c) Pond, dam, and spillway should be fenced from stock to protect vegetation, reduce spread of disease, etc.

17 Provide for irrigation facilities, if needed

(a) Pipe or conduit through the dam should be of sufficient size to provide an adequate irrigating head

(b) Provide control valve or gate

(c) Comply with state requirements concerning water rights.

18 Provide farmstead water supply facilities, if needed

(a) Pipe through dam to furnish water by gravity, or to a hydraulic ram, or pipe from pond to windmill or other pump

(b) Provide filter to clarify water

(c) Provide chlorinator or other purifying device

(d) Conform to any other requirements as provided for in state laws pertaining to sanitation or water rights.

19 Provide for fish production in the pond, if desired

(a) Fence to protect from livestock

(b) Regrade pond margins to provide a minimum of 2-ft depth of water at all points in pond for normal stages of water surface. Where a large fluctuation in the water surface is expected, make the sides of the pond steep to a depth below the probable low water level

(c) Make provision for draining the pond.

20 Obtain approval of plans by state agencies, if required by law. Also, make application for water rights if this is required by law.

Engineers of Production

WHILE the agricultural engineers are not in a position to determine world food needs during a global war, once the food requirements are defined and the patterns of production outlined, they should be able to utilize efficiently the available resources of power, equipment, and labor to obtain the maximum productive return. As one of the prominent members of the American Society of Agricultural Engineers has so well stated, "Farm equipment constitutes the machine tools of agriculture". A factory without tools has no output, while an efficient factory has its production equipment geared to its desired output. The agricultural engineers are in a position to gear the equipment needs to production in their respective areas when they know the kinds and volumes of crops needed for the war effort. Members of the A.S.A.E. are now rendering such service in the field and in government offices.

A Laboratory Study of Crop Duster Problems

By Frank Irons

MEMBER A.S.A.E.

ECONOMIC control of insects and plant diseases on many field crops by dusting depends upon the efficient performance of the dusting mechanism. Duster problems have become more troublesome in recent years because of the introduction of many new combinations of dust materials which are difficult to apply. The application requirements established by the entomologists and plant pathologists are becoming more rigid and exacting.

It is recognized that dusting and spraying are in many cases alternative methods which may or may not be competitive. However, it is the purpose of this paper to report on opportunities for improving the mechanical performance of dusters. As long as there is the possibility of obtaining comparable or improved control results with 20 to 40 lb of dust per acre as against 1000 to 2500 lb of spray liquid, there is much incentive for making the most effective use of the dusting method.

The difficulties we encountered in field experiments emphasized the need for controlled laboratory experimentation and development with dusting machines. The Division of Agricultural Engineering of the USDA Bureau of Plant Industry, Soils, and Agricultural Engineering has been conducting a laboratory study of multiple-outlet power dusters as part of the pest control machinery program. Investigations up to now have been confined primarily to studies of feed mechanism performance, dust and air distribution between nozzle outlets, and fractionation of dust occurring within the duster.

For test purposes in the laboratory, a multiple dust collector (Fig. 1) was developed, which collects separately all of the dust discharged from individual nozzles without affecting the flow of air through the duster. The apparatus consists of a chamber 14 ft long, 8 ft wide by 6½ ft high to which is connected an exhaust fan (Sirocco No. 2). An entrance door is provided for access to the chamber. Dust collector bags (Fig. 2) are suspended horizontally across the chamber with the open ends extending through openings in the front panel. The bags are 8 ft long by 11 in in diameter and are made of heavy outing flannel with steel wire rings sewed into the ends. One bag is used for each nozzle of the duster being tested. The bags are quickly detachable from the unit.

The duster to be tested is set up in front of the collector with each nozzle set to direct the dust-laden air blast through a bag opening. The exhaust fan maintains a partial vacuum within the chamber causing the dust blast to be drawn into the bags where the dust is trapped while air passes through and is exhausted from the chamber. A partial vacuum, of less than one inch of water, is required at the beginning of a test with a maximum requirement of less than 4 in at the end, depending upon the amount of dust collected.

The bags are cleaned between each test with a bag cleaning device connected to the exhaust fan.

The amount of dust discharged from each nozzle outlet is determined by weighing the collector bags before and after operating the duster for a timed test period. By using the net weights of dust collected both the feed rate and distribution between nozzles is calculated. Fractionation determinations are made by analysis of representative samples taken from each collector bag.

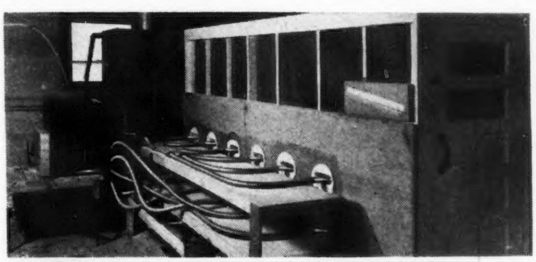
Air delivery determinations are made by means of a calibrated anemometer and a special adapter tube (Fig. 3). The enlarged end of the adapter is covered with a divided end plate with an opening for entrance of a duster tube with nozzle attached. Rubber sealing gaskets prevent leakage at the enclosed end. An air straightener is located near the outlet end. The outlet end of the adapter is 6 in in diameter. The design of this adapter converts the unequal air velocities from the nozzle to a uniform readily measurable lower range with negligible back pressure effect on the unit being tested. Readings are taken of each nozzle with the anemometer at five positions fixed by a locator plate at the outlet end. Average indicated feet per minute are converted to corrected feet per minute by the calibration curve for the anemometer. Computations then give both total air volume and air volume for each individual outlet. All air flow readings are made without dust delivery.

The above method for determining air delivery was adopted because of the uneven velocities at the outlets of all spreader nozzles. The adapter tube provided a simple means of directing all of the air uniformly through a known orifice area large enough to avoid back pressure.

The numerous kinds of dust materials used are of widely varying physical characteristics, which affect duster performance. Among 47 different dusts included in a preliminary study, the densities ranged from 9 to 96 lb per cu ft. Variations in average particle size ranged from 1.7 to 30.5 microns. The total range in particle size of most individual dusts is much greater, particularly the diluents. These facts make it necessary to closely correlate machine tests with a study of dust materials.

Two different models, each of five makes of dusters, making a total of ten machines, have been included in the performance tests. Dusters were operated at speeds recommended by their respective manufacturers. All attachment parts as nozzles, conductor tube combinations and arrangements were standard. Dust materials and formulas were those commonly used in pest control.

Unreliable feed rate control is one of the greatest faults of commercial dusters and should be given primary consideration for improvement. Under the controlled laboratory conditions much difficulty was experienced with all makes of dusters in attempting to arrive at a desired feed rate. Common commercial machines employ various types of feed agitators operating over and near a single or multiple dust port with control depending on variable size of opening as governed by a sliding gate. Peripheral speeds of the agi-



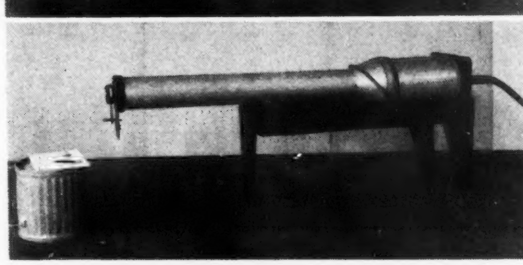
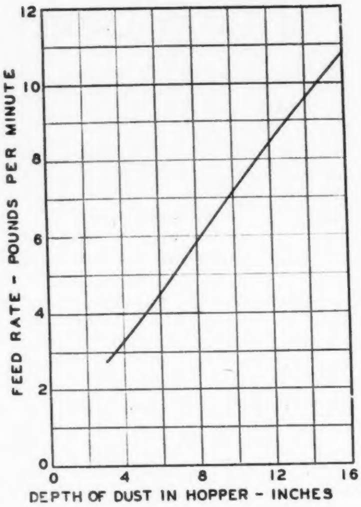


Fig. 1 (Top) View of multiple dust collector with duster set up for performance test. Collector bags are shown extending through the front panel of vacuum chamber • Fig. 2 (Center) Collector bags suspended in vacuum chamber with vacuum applied • Fig. 3 (Bottom) Adapter tube used for making air volume determinations

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Lafayette, Ind., June, 1943. A contribution of the Power and Machinery Division.

FRANK IRONS is senior agricultural engineer (BPISAE, ARA), U. S. Department of Agriculture.



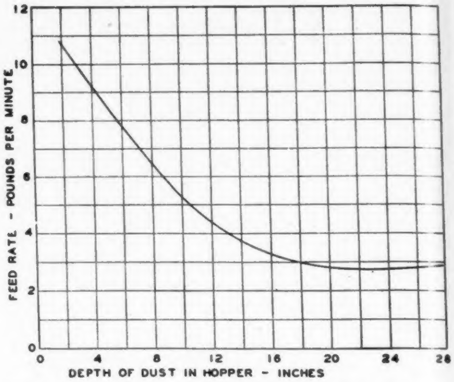


Fig. 4 (Left) Feed rate at varying hopper dust level of a high-speed agitator duster • Fig. 5 (Above) Feed rate at varying hopper dust level of a low-speed agitator duster

tators ranged from 15 to 6500 fpm. The feed rate was affected by both depth of dust in the hopper and changing dust condition resulting from agitation and vibration. High speed agitators gave irregular feed rate varying with amount of dust in hopper (Fig. 4).

Machines with low speed agitators showed less effect due to amount of dust in the hopper, but more effect from variable dust conditions and showed a tendency to bridge with some dusts. The characteristic feed rate of this type is shown in Fig. 5. The feed is fairly uniform for the top half of the hopper, but increases rapidly thereafter. This is due to changed dust condition resulting from fluffing action of the agitator.

Intermediate agitator speeds ranging from about 500 to 2000 fpm were affected by both amount and condition of dust but to a smaller degree and showed a wider range of adaptability. The lubricating effect of a relatively small volume of air thoroughly mixed through a mass of dust changes its feeding characteristics tremendously. Many dust materials lose most of their interparticle friction and behave almost as non-viscous fluids when air is permitted to reach the agitator mechanism. Any change in the condition of a given dust at the time it is placed in the hopper also affects the feed rate. For example, one standard fungicide formula, which was well settled from standing, was placed in the hopper with little disturbance to the material. The feed rate at a selected setting was 4.46 lb per min. A bag of the same material was conditioned similar to that which obtains shortly after mixing and was placed in the same machine. The feed rate of this conditioned dust with the same feed setting as before was 11.49 lb per min, or an increase of 158 per cent.

The variation in densities of different dusts naturally affects feed rate due to differences in weight-volume relationship. However, there is no significant correlation of feed rate of different kinds of dusts on a volume basis.

The operator of a duster may obtain the maximum protection possible against uneven feed rate by maintaining the dust level well above the feed agitator at all times. This will require more frequent filling, but he should be amply rewarded in better crop protection and considerable saving in expensive and critical dust materials.

Distributors of multiple outlet dusters may be divided into two general groups, namely, (1) fan case distributors with individual outlets around the periphery of the fan housing and (2) manifold distributors attached to a single outlet fan. Air distribution to nozzle outlets was found fairly uniform with most of the machines tested. Differences in conductor tube lengths accounted for the wider variations in air deliveries. It is a common practice to balance the distribution as much as possible by connecting the longer tubes to the higher delivery outlets.

The wide variations in duster size, tube length, and tube size result in considerable difference in air deliveries through individual tubes. Air delivery through the individual tubes of the different dusters ranged from 27 to 129 cfm. Average air velocities in tubes varied from 3,200 to 11,000 fpm. Tube velocities lower than 4,000 fpm resulted in objectionable deposits of dust in the tube. Extremely high velocities cause rapid wear from abrasion. The matter of dust abrasion is being given separate consideration at this time.

Air distribution of most dusters is more uniform than dust distribution. Factors which affect air distribution, although indirectly affecting dust distribution, do not show any close correlation between the two. The lack of correlation between air and dust distribution is shown in Fig. 6. Here the air is fairly uniform, but dust distribution is extremely poor with nozzle No. 2 receiving 19.35 per cent of all the dust, while nozzle No. 12 receives only 2.52 per cent. When this difference is multiplied by the difference in feed rate at variable hopper levels, the variation is much greater and most certainly would affect field performance.

Wide variations in dust distribution were measured in most duster models when this investigation was begun. It is encouraging to be able to report that much progress has been made by the manufacturers in overcoming this difficulty. An example of the most uniform dust distribution measured is shown in Fig. 7. The dust in this case is more uniform than the air.

Feed rate affects dust distribution to a marked degree with the old manifold types of distributors and to a lesser degree with the fan case type distributors. With the manifold type the distribution improves as the feed rate is increased. The reverse is generally true of fan case distribution.

Fractionation or mechanical separation of dust materials which occurs within the duster has been closely associated with the problem of dust distribution. The primary cause of fractionation is the differences in physical characteristics of dust materials. This fact should be given careful consideration when selecting ingredients for a dust mixture. Fractionation has occurred in varying degrees in tests with both insecticidal and fungicidal dust mixtures. To cite an example of fractionation, a 7 per cent copper dust formula was used in a test with a 12-outlet duster giving poor distribution. Chemical analysis of representative samples collected from two different nozzles showed one with 5.5 per cent copper and the other with 9 per cent copper. With any given dust mixture this difference varies with the dust distribution and is particularly pronounced at low feed rates. Objectionable separation has not been found when dust distribution was reasonably uniform.

It appears evident from results of these laboratory studies that new developments and improvements in duster design are needed to overcome feed rate control, distribution, and fractionation difficulties encountered with most of the current makes of dusters.

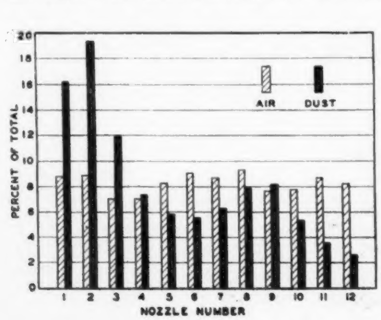
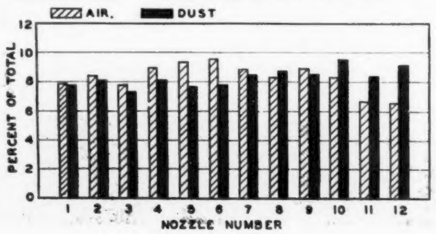


Fig. 6 (Left) Air and dust distribution to nozzles of a 12-outlet duster showing lack of correlation • Fig. 7 (Below) Air and dust distribution to nozzles of a 12-outlet duster showing the most uniform dust distribution measured. Dust is more uniform than air



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IMAGINEERING AT WORK

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NEWS SECTION

A.S.A.E. Meetings Calendar

December 6 to 8—Fall meeting, La Salle Hotel, Chicago, Illinois.

February 1 and 2 — Southeast Section, Henry Grady Hotel, Atlanta, Georgia.

June 19 to 21 — Annual Meeting, Hotel Schroeder, Milwaukee, Wis.

A.S.A.E. Fall Meeting at Chicago

THE usual Fall Meeting of the American Society of Agricultural Engineers will be held at the LaSalle Hotel, Chicago, December 6 to 8.

The first period of the meeting, Monday forenoon, December 6, will consist of two concurrent programs, on farm power and machinery and farm structures.

The farm machinery program will open with a report on the farm machinery situation with regard to meeting 1944 farm requirements by George Krieger, director, farm equipment division, War Production Board. Two speakers, F. W. Duffee, University of Wisconsin, and A. J. Schwantes, University of Minnesota will then discuss "Interchangeable Power Units for Farm Machines." The program will be concluded with the subject "What New Farm Machinery Developments Are Needed," which will be discussed by E. G. McKibben of Michigan State College, A. P. Yerkes of International Harvester Co., and E. J. Baker, Jr., of Farm Implement News.

The farm structures program, concurrent with the foregoing will open with a report by J. W. Simons of the War Food Administration on wartime problems in farm building construction. The subject "Structures Standards for Varying Farm Needs" will be discussed by Carl Oberlin, Martin Steel Products Co. E. W. Dienhart, National Concrete Masonry Assn., will talk on the proposed American Standard Basis for the coordination of masonry. The concluding number on this program will be a paper on one-story vs. two-story dairy barns by C. H. Jefferson of Michigan State College, with the discussion being led by H. W. Dearing of the Tennessee Coal, Iron and Railroad Co.

The period of Monday afternoon, December 6, will also be given over to two concurrent programs on farm power and machinery and farm structures.

Opening the power and machinery program, F. A. Wirt will give a preview of the projected program of the 1944 federal farm equipment campaign, as related to the farm machinery phases. Dr. M. D. Gjerde, Standard Oil Company of Indiana, will then discuss developments in engine lubricants. The subject "Engine Fuels" will be presented by Thos. H. Risk of the Ethyl Corp., and at the conclusion of his paper, Mr. Risk and representatives of four leading internal-combustion engine manufacturers will sit as a panel to answer written questions on fuels and engines submitted by those in attendance. In addition to Mr. Risk, this panel will consist of Earl Ginn, Continental Motors Corp., J. B. Fisher, Waukesha Motor Co., A. F. Milbrath, Wisconsin Motor Corp., and D. W. Latta, Hercules Motor Corp.

The farm structures program for the same period will open with a preview of the 1944 food production campaign as related to farm structures by K. J. T. Ekblaw. C. I. Anthen of the Tennessee Coal, Iron and Railroad Co., will then discuss improvements in structural steel and methods of fabrication and erection. New developments and applications of structural boards will be discussed by Christ L. Christensen of the Celotex Corp. "New Hard-Surfaced Poultry House Floors" will be the subject of a paper by Ralph L. Patty of South Dakota State College. The program for this session will be concluded with a paper on teaching repair and maintenance of farm structures in vo-ag schools by K. J. T. Ekblaw, American Zinc Institute.

The only general session of the meeting will be held Tuesday forenoon, December 7, and will be presided over by President Arthur W. Turner of the A.S.A.E. It will feature two subjects of outstanding interest to agricultural engineers. The first will be a talk on the opportunities for agricultural engineers in agricultural rehabilitation work in occupied areas by George L. Bell of the Foreign Economic Administration. The discussion of Mr. Bell's talk will be led by H. S. Pringle of the Office of Civilian Requirements. Dean E. C. Young of the graduate school of Purdue University will discuss the farm work simplification study project which he is directing, the discussion of which will be led by H. E. Pinches of Harry Ferguson, Inc.

Three programs will be presented on Tuesday afternoon, December 7. One, a combined program on power and machinery and

soil and water conservation, will be presented concurrently with one on rural electrification and another following it, on farm structures.

The farm machinery–soil and water program will open with a paper on the subject "The Machinery Factor in the Soil Conservation Program," by Dr. T. S. Buie of the U. S. Soil Conservation Service. This will be followed by a paper on engineering developments in soil and water conservation by T. B. Chambers, also of the SCS. How farm machinery manufacturers are meeting the requirements of soil and water conservation will be discussed by C. H. Zirckel of the International Harvester Co., and Frank Kranick of the J. I. Case Co. R. A. Norton will present a paper on "The Present Status of the Plow as a Tillage Implement." The program of this session will be concluded by a paper on building and maintaining of terraces with the moldboard plow by R. C. Shipman of Purdue University and R. O. Cole of the SCS.

The rural electric program for the same period will open with a paper by D. C. Sprague of Pennsylvania State College on electric equipment maintenance programs for vo-ag schools, and the subject of electric motor repair schools will be discussed by H. J. Gallagher of Consumers Power Co. H. S. Pringle of the Office of Civilian Requirements will report on the supply and distribution of farm electric equipment and materials for 1944. The 1943 results in the use of home dehydrators will be reported on by G. E. Henderson of the Tennessee Valley Authority.

The program on farm structures which follows the preceding program, will be opened with a report of the Farm Structures Advisory Committee by W. G. Kaiser, chairman. A progress report on the dairy cow housing research project at the University of Wisconsin will be made by S. A. Witzel of that institution. Functional requirements of farm buildings, in the form of a progress report, will be presented by Wallace Ashby and T. A. H. Miller of the USDA Bureau of Plant Industry, Soils, and Agricultural Engineering. B. A. Jennings of Cornell University will present a progress report on the woven wire fencing exposure tests. The program will be concluded with a paper on "Methods of Repairing Farm Buildings" by J. C. Wooley, University of Missouri.

Wednesday forenoon, December 8, will be devoted to two concurrent programs, one on rural electrification and the other on soil and water conservation.

The rural electric program will open with a preview of the projected program of the 1944 federal farm equipment campaign, as related to rural electrification, by H. J. Gallagher. This will be followed by a paper on "Farm Electric Equipment to Meet Postwar Requirements," by Geo. W. Kable of Electricity on the Farm. C. H. Leatham of the Monongahela West Penn Public Service Co. will address the meeting on the present challenge of rural electrification. Grover C. Neff of the Wisconsin Power and Light Co. will deliver an address entitled "Looking Ahead in Rural Electrification".

The soil and water program will open with a paper by E. G. Welch of the University of Kentucky on the subject "Mechanical Erosion Control on Cultivated Land Steeper Than Recommended Terraceable Slopes." A paper by V. A. Vanoni and J. T. Rostron will report a study on "A Baffle Type Energy Dissapater for Pipes and Culverts." Postwar developments in irrigation in the West will be discussed by John W. Haw of the Northern Pacific Railroad Co. Concluding the program of this session, L. A. Jones of the Soil Conservation Service will discuss legislation for drainage construction and maintenance.

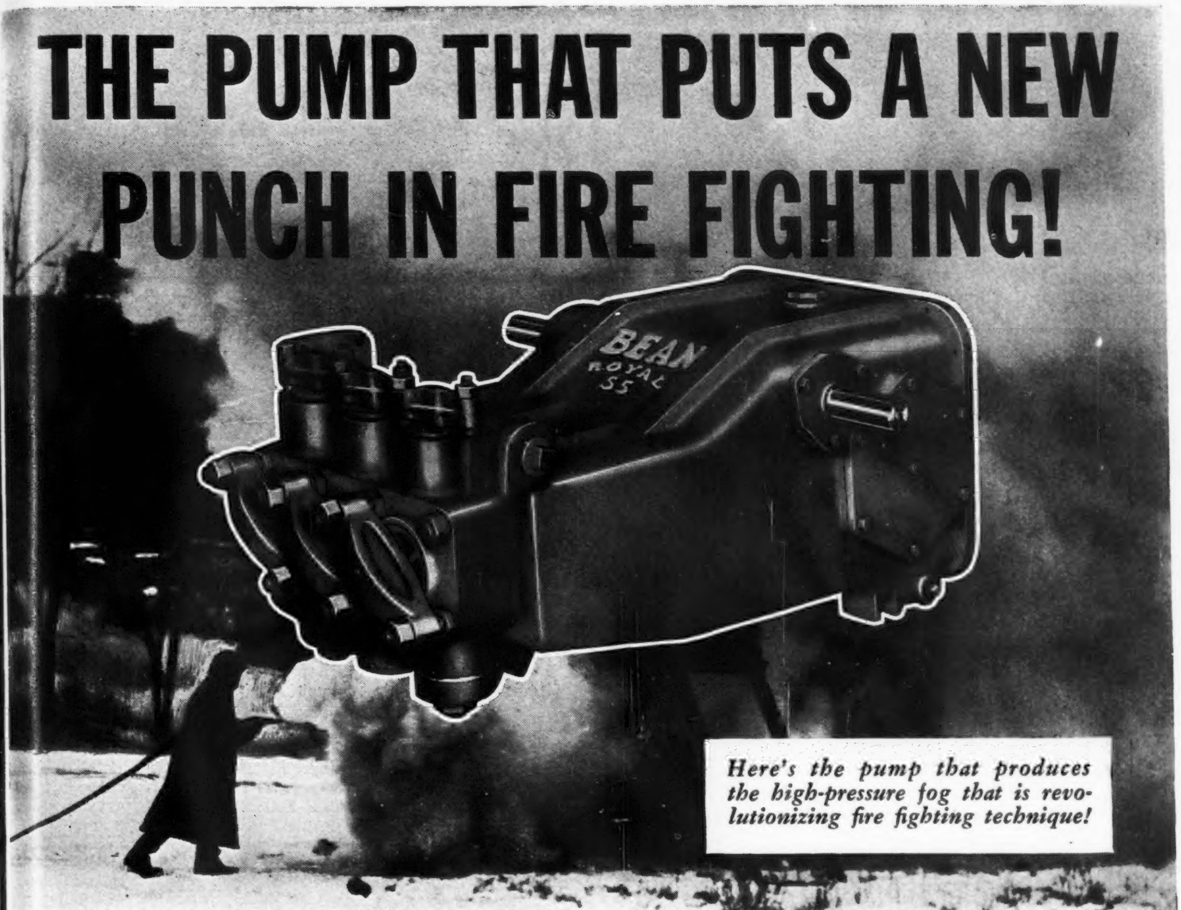
Wednesday afternoon, December 8, will also be given over to concurrent programs on rural electrification and soil and water conservation.

The rural electric program will open with a paper on rate freezing of fruits and vegetables in domestic type freezer cabinets by J. E. Nicholas and Miss Gilma Olson of Pennsylvania State College. This will be followed by a symposium on "Electric Aids in Farm Production," the principal topics and speakers being as follows: Grain elevators, J. D. Rankin, Detroit Edison Co.; lamps as a source of heat, L. C. Porter, General Electric Co.; and farm wiring problems, C. P. Wagner, Northern States Power Co.

The soil and water program to be presented concurrently will open with a discussion of how the USDA water facilities program aids the war effort by H. F. McColly of the Farm Security Administration. M. T. Thomson of the U. S. Geological Survey will discuss the need for water yield records from small watershed areas. Postwar plans for the soil and water conservation program will be discussed by M. L. Nichols, chief of research, U. S. Soil Conservation Service. The program of this session will be concluded with progress reports of several committees of the Soil and Water Division of the Society.

No formal program are being planned for the evenings during which the A.S.A.E. Fall Meeting is held, namely, December 6 and 7. They are being reserved for round-table meetings of committees and other groups, arranged by request. On Thursday, December 9, meetings of the Meetings Committee and other non-technical committees of the Society are being scheduled.

The Society extends a cordial invitation to all persons who are especially interested in the program of its Fall Meeting to attend



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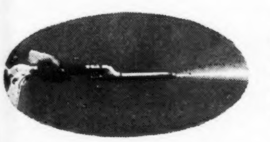

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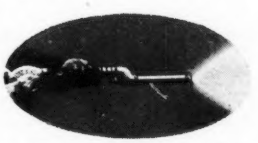

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any of the sessions in which they may have a particular interest. This applies to non-members as well as members of the Society. Further information in regard to the meeting and copies of the printed program may be obtained on request to the executive office of the Society at St. Joseph, Michigan.

Tennessee State Section Meeting

THE Tennessee State Section of the American Society of Agricultural Engineers held a meeting at Knoxville on October 30. Fourteen members of the Section were in attendance. There were also ten guests present. Out-of-state visitors included A. Carnes, regional engineering chief of SCS in the Southeast, and Russell Lord, editor of "The Land," who gave the Section an interesting talk on the movie of that name.

At the business session of the meeting the following officers were elected for the coming year: Chairman, G. E. Henderson, assistant chief, agricultural engineering development division, Tennessee Valley Authority; vice-chairman, McLemore Roberts, district conservationist, U. S. Soil Conservation Service; and secretary and treasurer, W. J. Browder, assistant extension agricultural engineer, University of Tennessee.

Southeast Section Meeting in Prospect

PLANS are now in the making to hold a meeting of the Southeast Section of the American Society of Agricultural Engineers at the Henry Grady Hotel, Atlanta, Georgia, February 1 and 2.

An imposing list of timely proposed subjects is being circulated to members of the Section, and the program for the meeting will be developed mainly on the basis of suggestions which the Section officers receive from members.

Farm Buildings Repair Conference

A MASS meeting of representatives of all agencies interested in the farm buildings field is to be held at the LaSalle Hotel, Chicago, on December 10, 1943, immediately following the fall meeting of the American Society of Agricultural Engineers held earlier in the week. The meeting is being held under the auspices of the War Food Administration and the Farm Structures Division of A.S.A.E. Problems on the general subject of farm building repair in relation to the National Food Production Program will be discussed. Agricultural engineers, extension specialists, county agents, vo-ag instructors, building material producers, farm and buildings trade press, and others are invited to attend.

Details of the program can be obtained from K. J. T. Ekblaw, 35 E. Wacker Drive, Chicago 1, Ill., chairman of the committee on local arrangements.

Personals of A.S.A.E. Members

William F. Ackerman has joined the agricultural engineering staff at Pennsylvania State College as instructor in ag engineering research. Prior to this appointment he was employed by the Rural Electrification Administration.

Mills H. Byrom, associate agricultural engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA, has been recently transferred from the USDA cotton ginning laboratory at Stoneville, Miss., to Lake Worth, Fla., where he will be engaged in the sansevieria fiber processing investigation being conducted there by the Department.

George W. French was recently appointed an assistant agricultural engineer in the Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, and will be located at Ames, Iowa, where he will be engaged in the grain storage investigations carried on there by the Bureau. Previously he was employed in the engineering department of Skelly Oil Company in Kansas.

W. V. Hukill, senior agricultural engineer, USDA Bureau of Plant Industry, Soils, and Agricultural Engineering, who has more recently been located at Wenatchee, Washington, has recently been transferred to Ames, Iowa, where he will have charge of the grain storage investigations at the federal laboratory located on the campus of Iowa State College.

William Kalbfleisch, agricultural engineer, field husbandry division, Experimental Farms Service, Dominion of Canada, is author of Farmers' Bulletin 118, entitled "Cost of Operating Farm Machinery in Eastern Canada," recently issued.

Ordean E. Olson recently resigned as state agricultural conservation engineer for the State of North Dakota for the Agricultural Adjustment Agency, to become farm manager for James F. Bell & Sons. He will have complete charge of the Bell family farms in Minnesota, with headquarters at Redwood Falls, Minn.

(Personals continued on page 394)

H. S. Pringle, is now chief of the farm supplies and repair s[ec]tion, Office of Civilian Requirements. Until his transfer recen[tly] he was chief of the farm equipment repairs branch, farm equ[ip]ment division, WPB. He is on leave from Cornell University.

J. C. Wooley, head, agricultural engineering department, U[ni]versity of Missouri, is author of Circular 279, entitled "Farm Bui[ld]ing Repair," recently issued by that institution in furtherance [of] the war effort on the farm front.

Applicants for Membership

The following is a list of recent applicants for membership in [the] American Society of Agricultural Engineers. Members of the Society [are] urged to send information relative to applicants for consideration of [the] Council prior to election.

Wayne H. Carver, editor, Locker Publications Co., 1421 Waln[ut,] Des Moines 9, Iowa.

Charles A. Court, southern representative, Louden Machin[ery] Co. (Mail) 3560 Norriswood Place, Memphis, Tenn.

C. W. DuBois, associate professor, food preservation depa[rt]ment, Louisiana Experiment Station, Baton Rouge 13, La. (Ma[il)] 3236 Carlotta St.

R. D. Escalante, direccoin de agricultura, Ministerio de Ag[ri]cultura, Caracas, Venezuela.

J. B. Gibbs, manager, International Harvester Co. (Mail) 10[..] Margaret St., Des Plaines, Ill.

Harold V. Hansen, project engineer, Harry Ferguson, In[c.] Dearborn, Mich. (Mail) 3327 Gertrude.

O. H. Lovelace, consultant designing engineer, Canadian Co-[op] Implements, Ltd., Regina, Sask., Canada.

W. J. Nemerever, research fellow, Iowa State College, Am[es,] Iowa (Mail) 503 Stanton Ave.

Nelson E. Reynolds, experimental engineer, Harry Fergus[on,] Inc. (Mail) 827 12th St., Greeley, Colo.

R. M. Riemenschneider, factory representative, Louden M[a]chinery Co. (Mail) 4317 East Washington St., Indianapolis, I[nd.]

George W. Schenk, district representative, Louden Machin[ery] Co. (Mail) Box 87, Nadeau, Mich.

Sidney C. Smith, special representative, International Harves[ter] Co. (Mail) 982 N. Graham St., Memphis, Tenn.

Oscar Solum, sales engineering, Louden Machinery Co. (Ma[il)] Box 147, Alexandria, Minn.

Wilson T. Stewart, assistant farm line manager, Louden M[a]chinery Co., Fairfield, Iowa, (Mail) 200 West Madison St.

S. C. Turkenkopb, manager of engineering, B. F. Avery a[nd] Sons Co., Louisville, Ky.

F. C. Vierk, district engineer, U. S. Department of Agricultu[re] (Mail) 2719 Fern St., Little Rock, Ark.

A. S. Yates, agricultural field engineer, Louden Machinery C[o.] (Mail) 553 Glendale Ave., St. Paul 4, Minn.

TRANSFER OF GRADE

Russell G. Broaddus, Maj., AAC. (Mail) 412 Glenwood Av[e.] Raleigh, N. C. (Junior Member to Associate)

Student Branch News

IOWA

KENNETH W. SNYDER, *Acting Scribe*

THIS report of our student branch activities will be short [as] they have been limited to informal get-togethers. The first me[et]ing of the fall quarter was called October 13 by President Vinc[ent] Webster. There were four members present, which represented t[he] greater part of our non-service men. (There are four men in t[he] A. S. T. P. stationed at Iowa State.) At present a student facu[lty] mixer is being planned for October 27. This mixer is an annu[al] event and promises to be of the prewar quality even though it w[ill] not be up to our former standards of attendance.

On October 14, Dr. J. B. Davidson announced that all of l[ast] year's graduates have now entered the armed services. The agric[ul]tural engineering department is the only department on the camp[us] that has made this record. We civilians who are left to gradu[ate] wish to publicly thank these men as well as the men who we[re] called before they had a chance to graduate. We also wish [to] pledge ourselves to keep this record and to keep the ag engineeri[ng] service stars ever increasing.

In closing, I wish to say that even though we may not be ab[le] to have a recognized student branch, we will carry on our inform[al] activities. Our president, Vincent Webster, is taking care of t[he] administrative duties such as those of secretary and treasurer a[nd] is also representing us on the Engineering Council. Webster and m[y]self (the only two seniors) wish the other student groups good lu[ck] and hope that they will carry on and be of service to their schoo[ls.]

Agricultural Engineering Digest

A review of current literature by R. W. Trullinger, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the address indicated.

Surfaces and Underground Waters of Ohio, *W. Stout, C. V. Youngquist,* and *R. E. Lamborn.* Ohio Engin. Expt. Sta. (Columbus) Cir. 43 (1942). This circular contains a foreword by C. E. MacQuigg, director of the Ohio Engineering Experiment Station, followed by discussions (1) of the conservation of Ohio's water resources, by Stout; (2) of the surface waters of Ohio, by Youngquist; and (3) of the underground waters of Ohio, by Stout and Lamborn.

The first of these discussions calls attention to the existence of a serious water supply problem in Ohio, with current average consumption per capita of from 80 to 100 gal, constantly increasing and with increasing industrial demands, spread of irrigation, and other growing uses. Practicable ground-water supplies occur mainly over former river valleys buried by glaciation. Only about one-half the area of the state has these resources. Utilization of about one-twentieth of the average run-off would meet current needs, but there is need to "practice every known method possible to put water back into the ground wherever it can be restored."

The second paper, taking up surface waters, briefly discusses gaging and flow measurements, rainfall, and reservoirs. The last-named subject is especially emphasized from the viewpoints both of supply and of flood control. "Control will consist of the construction of large reservoirs for storing of excess flood waters for release during drought periods. The benefits of such a program over a long period will greatly outweigh the cost."

The third paper, on underground waters, takes up the subjects of water from glacial deposits (the source of the greater part of the ground water available in Ohio), and water from deposits of stratified rock. This discussion is based largely upon the geological map of the state. The authors conclude that "more than one-half of Ohio is so physically constituted through a thick blanket of glacial drift or through porous rock strata at the surface that the supply of ground water is ample to meet the common needs of the farm, factory, or town." In the remainder of the state, however, the supply of ground water is generally meager and uncertain.

Hydraulic Studies of Conservation Structures at the Outdoor Hydraulic Laboratory, Spartanburg, South Carolina. U. S. Dept. Agr. (Washington) Soil Conserv. Serv., and South Carolina Sta., (1942). This publication presents a general description, accompanied by numerous photographs, of equipment built and experiments carried out to test small experimental erosion control dams and waterways. Among the structures described and shown are an impounding reservoir capable of a maximum flow of 35 cfs for about 1.5 hr with a lowering of the water level not greater than 1 ft; a Bermuda grass sodded canal used to carry the water supply and built to follow the contour of the hillside; a model testing basin which provided a facility for testing conservation structures, including gully control structures, check dams, and farm pond spillways; experimental meadow strip waterways planted to various types of vegetation used to resist scouring and gullying; channels for testing the relative merits of various types of channel lining vegetation; and gaging equipment, measuring flumes, and other experimental set-up. Experiments illustrated include a notch test for the determination of the capacities of rectangular openings; tests of various channel linings, as Bermuda grass, centipede grass, kudzu vine, and a cotton-reinforced asphalt lining; etc. The results are stated in terms of qualitative comparisons among channel linings and meadow strip cover, etc. Constructional detail is not dealt with and no drawings are reproduced. It is noted that the Spartanburg work has been discontinued and similar work set up at Stillwater, Okla.

Overshot and Current Water Wheels: Design, Construction, and Installation for Small Power Developments on Ranch and Farm, *O. W. Monson* and *A. J. Hill.* Montana Ag. Exp. Sta. (Bozeman) Bul. 398 (1942). For both overshot and current wheels, general design is shown in drawings and discussed in detail sufficient to permit the builder to design and make the wheel in dimensions determined from local conditions and requirements. Parts are defined and indicated in the drawings, and their respective functions and essential characteristics are pointed out. For the overshot wheel, both a metal hub wheel otherwise of all wood construction and an all-metal construction are dealt with, together with wheel mountings, delivery chute with control gate, tail race, wheel shelter, power drive, etc. For the current wheel, only all-wood construction is recommended and described, with raft mounting, mounting in a flume, lifting mechanisms, and related details. *(Continued on page 400)*

Agricultural Engineering Digest

(Continued from page 396)

THE GREASE PROBLEM IN SEWAGE TREATMENT, *A. L. Fales* and *S. A. Greeley*. Amer. Soc. Civ. Engin. (New York) Proc., 68 (1942), No. 2. The quantity of "grease" found in sewage by the present standard method of analysis is largely dependent upon which of the three standard solvents is used for extraction. Furthermore, the standard method of determination of grease in sewage has proved not entirely satisfactory in other ways. The following steps appear to be desirable: (1) Agreement upon what substances should be included in the term grease, (2) adoption of a standard method for determination of grease in sewage as thus defined, and (3) accumulation of data based upon this standard method.

A considerable proportion of the ether-soluble matter can be removed by sedimentation and plain skimming. A somewhat larger proportion can be removed if the sewage is aerated prior to sedimentation and skimming. Aerochlorination prior to sedimentation and skimming accomplishes a still larger removal of grease. At present, however, available operating data are insufficient to form a basis for a sound conclusion as to the value of preaeration and of aerochlorination in the over-all removal of grease from sewage.

REDUCTION OF MINERAL CONTENT IN WATER WITH ORGANIC ZEOLITES, *R. F. Goudey*. Amer. Soc. Civ. Engin. (New York) Proc., 68 (1942), No. 2. The development of improved organic zeolites for the removal of positive and negative ions, completely or in part, provides superior methods for softening water, reducing sodium content, removing excess alkalinity, lowering sulfates, or reducing chlorides to produce suitable water for domestic, irrigation, and industrial uses, and in special cases where inconvenience, expense, or failure to secure an adequate working plan are involved. Although the costs of operation in the more aggravated cases may be relatively high, they are, in most cases, not prohibitive and are certain to be lower as increased production and availability of suitable materials develop. A quality comparable for many purposes with that of distilled water can be produced by treatment with organic zeolites.

CONCERNING PERMEABILITY UNITS FOR SOILS, *L. A. Richards*. (USDA). Soil Sci. Soc. Amer. Proc. 5 (1940). A permeability unit acceptable for general use in different lines of work must be based on a flow equation which is adequate to cover a variety of flow cases. The equation $v = k/n\ (\rho F - \Delta p) = (k/n)\rho\ gi$ seems to have certain advantages. In this equation i is the hydraulic gradient, v is the volume of water crossing unit area in the soil in unit time, and k is the Darcy coefficient of permeability. The quantity ρ is the density, F the body force per unit mass, p the pressure, n the viscosity, and Δ the gradient operator. For soil moisture flow, F represents the gravity force and is numerically equal to the acceleration of gravity, g. "The k in this equation could be referred to as the cgs unit of permeability, or in view of the various meanings associated with permeability it might be desirable from analogy with the treatment of thermal and electrical flow in physics to designate this k as 'fluid conductivity.' There is precedence for such a name in the literature of both soil science and engineering."

STRESSES IN A CURVED BEAM UNDER LOADS NORMAL TO THE PLANE OF ITS AXIS, *R. B. B. Moorman*. Iowa Engin. Expt. Sta. (Ames) Bul. 145 (1940). This report presents algebraic analyses (1) of the stresses in a curved beam of any cross section in which there is little or no bending moment induced in planes parallel to the plane of the axis of the beam, and (2) of the circular-arc beam of I cross section loaded by single concentrated loads, together with the load and deformation measurements for comparison with results obtained from each analysis. Load and deformation measurements were made on a curved round steel rod and a curved I beam. The rod was bent cold and tested unannealed. The I beam was bent cold and tested in both unannealed and annealed conditions.

The conclusions drawn are held to form a sound basis for the determination of structural strengths of horizontally curved beams subjected to vertical loads.

PRESSURE AND STREAMLINE DISTRIBUTION IN WATERLOGGED LAND OVERLYING AN IMPERVIOUS LAYER, *D. Kirkham*. (Utah Ag. Exp. Sta.) Soil Sci. Soc. Amer. Proc. 5 (1940). The author obtained photographs of streamline flow patterns by placing wire gauze models of tile drains in uniform sand and in stratified soil layers held in tanks having plate-glass fronts at right angles to the drains, water being colored by potassium dichromate. An impervious layer was placed at various depths below the soil surface. Photographs of flow in models representing various depths and spacings of drains are reproduced, and their significance is briefly discussed.

COTTON-GIN MAINTENANCE, *C. A. Bennett* and *F. L. Gerdes*. U. S. Dept. Agr. (Washington) Leaflet 216 (1942). Better quality of the ginned products, increased capacity, improved performance of the ginning outfit, and lower cost of operation result from the prompt repair and adequate maintenance of the ginning equipment. Losses in the money value of the ginned lint from brushes in poor condition were found to average from 80c on short-staple to as much as $1.50 on damp long-staple cottons. Replacing worn brushes decreased ginning time from 7 to 10 per cent. Losses from air-blast nozzles improperly adjusted averaged as much as $1 a bale on long-staple cotton ginned in a moist condition. Losses from ginning with saws in poor condition averaged $2 a bale with long-staple cottons, and ginning was 25 per cent slower than it would have been had the saws been in good condition. An overhaul of gin saws was needed in more than one-fourth of 500 representative gins surveyed in 1940. When making these repairs is a good time to speed up slow saw cylinders in the older gins operating their saws at or below 500 rpm (approximately 45 per cent of the gins in the cotton belt). Similarly, repair and maintenance of conveyors and distributors may often give opportunity for providing pure seed-handling systems. At present only a small percentage of all cotton gins in the United States are so equipped. Checking up shafting, bearings, and drives permitted brush repairs needed in over one-third of the gins and rib repairs in almost one-third of the gins inspected. In repairing gins, a good plan is to systematically check all important elements of ginning along the route over which the cotton passes.

This leaflet provides a general guide for repairing and modernizing ginning machinery. The topics specifically dealt with are checking pneumatic cotton-handling equipment; inspecting drying, cleaning, and feeding equipment; putting gin stands in shape; modernizing gin breasts; necessary attention to gin saws; testing lint-doffing systems; ginning bearings, belts, and pulleys; providing pure seed-handling equipment; inspecting lint-handling systems; checking kicker, tramper, and press; maintaining gin building; and care of the gin during the idle season.

BUILDING ELECTRICAL EQUIPMENT FOR THE FARM, *W. A. Ross*, *W. P. Beard*, *J. Deiss*, and *L. C. Prickett*. Fed. Security Agency, U. S. Off. Ed. (Washington) Vocat. Div. Bul. 209 (1940). This bulletin is planned to provide teachers of vocational agriculture with reliable subject matter organized in usable teaching form to facilitate systematic instruction on building safe and simple electrical equipment for the farm. It contains a foreword by J. C. Wright, assistant U. S. Commissioner for vocational education; a general introduction; hints on planning farm wiring, maintenance, and repair; and directions and drawings for the following 10 specific construction jobs: making an electric poultry water warmer and an ultraviolet reflector for poultry; building an electric pig brooder, hotbed, and stock-tank water heater; rigging up a portable electric motor; assembling a motor dolly; building an electric chick brooder and pen; and making an exhaust fan room-cooling unit and a combination electric room-cooling and garden-irrigating device. A list of over 200 uses for electricity on the farm, some commonly used electrical terms and their meanings, and references on electricity are also included.

EFFICIENT USE OF FARM PRODUCTION EQUIPMENT, *H. H. Musselman*. Michigan Ag. Exp. sta. (East Lansing) Cir. 183 (1942). This circular contains brief discussions of power and equipment resources, the individual nature of the problem of appraisal and analysis of resources for each farm, making the most of machinery, optimum loads for tractors, training for farm jobs, field work suitable for women, practicability of cooperation, costs involved in the use of farm machinery, machine capacity, the fitting of the machine to the job, and time-saving suggestions. The topic dealt with most fully is that of costs, under which head are taken up indirect costs, with some discussion of depreciation, life of machines, interest, repairs and obsolescence, and a shorter method of calculating indirect costs; direct costs and their estimation; use of cost estimation figures; and cost comparisons.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE WISCONSIN STATION. Wisconsin Ag. Exp. Sta. (Madison) Bul. 455 (1942). This report notes an experiment by L. F. Graber and F. V. Burcalow with a "quick haymaker" or roller crusher which picks up the hay as cut and crushes the stems between rollers, the mixed hay having dried to 14 per cent 24 hr after crushing but only to 29 per cent moisture content when cut without crushing, and simple methods of building temporary or permanent pen barns, by S. Witzel, E. Heizer, E. Zehner, and A. Einerson.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE NEW MEXICO STATION. New Mexico Ag. Exp. Sta. Rpt. 1941. Under the heading of irrigation are noted duty-of-water investigations and rate and cause of rise of ground water in the Mesilla Valley.

Agricultural Engineering Digest *(Continued)*

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE TENNESSEE STATION. Tennessee Ag. Exp. Sta. (Knoxville) Rpt. 1940. M. A. Sharp reports upon a legume-seed scarifier, lime and fertilizer spreader, legume silage experiments, and a milk pasteurizer. Work on erosivity and infiltration capacity of soils is noted by A. L. Kennedy.

PROFESSIONAL DIRECTORY

Consulting Engineering Work In Farm Structures Field
Also Sales Engineering for Selected Manufacturers
George R. Shier, A. E.
Member A.S.A.E. Associated with Howard S. Sterner Company, Consulting Structural Engineers, 30 East Broad Street, Columbus, Ohio

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AD COPY WRITER wanted. Man with some technical experience who is creative and has the knack of writing simple, forceful copy for industrial and technical advertising is desired. Permanent position and good opportunity for advancement with long-established 4-A advertising agency. Correspondence will be kept confidential. PO-146

ENGINEERS wanted by large manufacturer of pumping and other farm equipment, which carries an "essential" rating. Married men free from draft call preferred. Applications must be in writing with complete statement of qualifications and experience. Include photo. State salary expected. PO-145

RESEARCH ENGINEER in electroagriculture wanted at The Pennsylvania State College, Department of Agricultural Engineering, State College, preferably a young graduate engineer vitally interested in research where engineering fundamentals are applied to problems in agriculture. The program includes research in freezing, cooling, and heating; illumination as applied to biological, physiological, and bacteriological studies; dehydration; use of power, as well as electronics.

RESEARCH ENGINEER wanted for design and development of agricultural machinery and equipment for the Southeast. Salary up to $3,000, depending on qualifications. Persons interested are requested to write giving full particulars regarding training, experience, and other pertinent information. PO-141.

POSITIONS WANTED

AGRICULTURAL ENGINEER with B. S. in both agriculture and mechanical engineering from midwestern university. Some graduate work in engineering. Desires position in college teaching, research, or extension, or with private concern. Has had experience in soil conservation, farm machinery and equipment, farm structures, and rural electrification. At present employed as a state extension agricultural engineer. Farm reared. Married. Age 38. Good reason for desiring a change of position. References and professional record available upon request. PW-357

AGRICULTURAL MACHINERY BLOCKMAN and collector, with three years in agricultural engineering work at Kansas State College, ten years' service with largest manufacturer of farm equipment, two years teaching in national defense training, and one year with farm machinery division of WPB, desires position in industry, or in any branch of agricultural engineering, farm management, or farm machinery design. Age 40, health excellent, no defects or bad habits, married, rural background. Complete credentials furnished upon request. Available October 16, 1943. PW-356

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